R&S®FSW-K10
GSM Measurement
User Manual

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Test & Measurement

User Manual

ROHDE&SCHWARZ

This manual applies to the following R&S®FSW models with firmware version 1.70 and higher:

- R&S®FSW8 (1312.8000K08)
- R&S®FSW13 (1312.8000K13)
- R&S®FSW26 (1312.8000K26)
- R&S®FSW43 (1312.8000K43)
- R&S®FSW50 (1312.8000K50)

The following firmware options are described:

- R&S FSW-K10 (1313.1368.02)

The firmware of the instrument makes use of several valuable open source software packages. For information, see the "Open Source Acknowledgement" on the user documentation CD-ROM (included in delivery).
Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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The following abbreviations are used throughout this manual: R&S®FSW is abbreviated as R&S FSW.

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1 Preface

1.1 About this Manual

This GSM Measurements User Manual provides all the information **specific to the application**. All general instrument functions and settings common to all applications and operating modes are described in the main R&S FSW User Manual.

The main focus in this manual is on the measurement results and the tasks required to obtain them. The following topics are included:

- Welcome to the GSM Application
  Introduction to and getting familiar with the application
- Measurement Results
  Details on supported measurements and their result types
- Basics on GSM Measurements
  Background information on basic terms and principles in the context of the measurement
- Configuration and Analysis
  A concise description of all functions and settings available to configure measurements and analyze results with their corresponding remote control command
- I/Q Data Import and Export
  Description of general functions to import and export raw I/Q (measurement) data
- How to Perform Measurements in the GSM Application
  The basic procedure to perform each measurement and step-by-step instructions for more complex tasks or alternative methods
- Optimizing and Troubleshooting the Measurement
  Hints and tips on how to handle errors and optimize the test setup
- Remote Commands to Perform GSM Measurements
  Remote commands required to configure and perform GSM measurements in a remote environment, sorted by tasks
  (Commands required to set up the environment or to perform common tasks on the instrument are provided in the main R&S FSW User Manual)
  Programming examples demonstrate the use of many commands and can usually be executed directly for test purposes
- **List of remote commands**
  Alpahabetical list of all remote commands described in the manual
- **Index**

1.2 Documentation Overview

The user documentation for the R&S FSW consists of the following parts:

- "Getting Started" printed manual

- Online Help system on the instrument
- Documentation CD-ROM with:
  - Getting Started
  - User Manuals for base unit and options
  - Service Manual
  - Release Notes
  - Data sheet and product brochures

Online Help

The Online Help is embedded in the instrument's firmware. It offers quick, context-sensitive access to the complete information needed for operation and programming. Online help is available using the ? icon on the toolbar of the R&S FSW.

Getting Started

This manual is delivered with the instrument in printed form and in PDF format on the CD. It provides the information needed to set up and start working with the instrument. Basic operations and handling are described. Safety information is also included.

The Getting Started manual in various languages is also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

User Manuals

User manuals are provided for the base unit and each additional (software) option.

The user manuals are available in PDF format - in printable form - on the Documentation CD-ROM delivered with the instrument. In the user manuals, all instrument functions are described in detail. Furthermore, they provide a complete description of the remote control commands with programming examples.

The user manual for the base unit provides basic information on operating the R&S FSW in general, and the Spectrum application in particular. Furthermore, the software functions that enhance the basic functionality for various applications are described here. An introduction to remote control is provided, as well as information on maintenance, instrument interfaces and troubleshooting.

In the individual application manuals, the specific instrument functions of the application are described in detail. For additional information on default settings and parameters, refer to the data sheets. Basic information on operating the R&S FSW is not included in the application manuals.

All user manuals are also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html.

Service Manual

This manual is available in PDF format on the CD delivered with the instrument. It describes how to check compliance with rated specifications, instrument function, repair, troubleshooting and fault elimination. It contains all information required for repairing the R&S FSW by replacing modules.

Release Notes

The release notes describe the installation of the firmware, new and modified functions, eliminated problems, and last minute changes to the documentation. The corresponding firmware version is indicated on the title page of the release notes.

The most recent release notes are also available for download from the R&S website, on the R&S FSW product page at http://www2.rohde-schwarz.com/product/FSW.html > Downloads > Firmware.

1.3 Conventions Used in the Documentation

1.3.1 Typographical Conventions

The following text markers are used throughout this documentation:

Convention	Description
"Graphical user interface elements"	All names of graphical user interface elements on the screen, such as dialog boxes, menus, options, buttons, and softkeys are enclosed by quotation marks.
KEYS	Key names are written in capital letters.
`File names, commands, program code`	File names, commands, coding samples and screen output are distinguished by their font.
Input	Input to be entered by the user is displayed in italics.
Links	Links that you can click are displayed in blue font.
"References"	References to other parts of the documentation are enclosed by quotation marks.

1.3.2 Conventions for Procedure Descriptions

When describing how to operate the instrument, several alternative methods may be available to perform the same task. In this case, the procedure using the touchscreen is described. Any elements that can be activated by touching can also be clicked using an additionally connected mouse. The alternative procedure using the keys on the instrument or the on-screen keyboard is only described if it deviates from the standard operating procedures.

The term "select" may refer to any of the described methods, i.e. using a finger on the touchscreen, a mouse pointer in the display, or a key on the instrument or on a keyboard.

2 Welcome to the GSM Application

The R&S FSW-K10 is a firmware application that adds functionality to perform GSM measurements to the R&S FSW.

The R&S FSW-K10 features:

- Measurements on downlink or uplink signals according to the Third Generation Partnership Project (3GPP) standards for GSM/EDGE, EDGE Evolution (EGPRS2) and Voice services over Adaptive Multi-user Channels on One Slot (VAMOS)
- Measurement in time, frequency or I/Q domains
- Measurement of signals ith GMSK, AQPSK, QPSK, 8PSK, 16QAM and 32QAM modulation, normal or higher symbol rate
- Measurement of signals using different Tx filters (e.g narrow and wide pulse)
- Measurements for Power vs Time, Modulation Accuracy and Modulation and Transient Spectrum as required in the standard

This user manual contains a description of the functionality that the application provides, including remote control operation.

All functions not discussed in this manual are the same as in the base unit and are described in the R&S FSW User Manual. The latest version is available for download at the product homepage.

Installation

You can find detailed installation instructions in the R&S FSW Getting Started manual or in the Release Notes.

2.1 Starting the GSM Application

GSM measurements are performed in a separate application on the R&S FSW.

To activate the GSM application

1. Press the MODE key on the front panel of the R&S FSW.

   A dialog box opens that contains all operating modes and applications currently available on your R&S FSW.

2. Select the "GSM" item.

   The R&S FSW opens a new measurement channel for the GSM application.

The measurement is started immediately with the default settings. It can be configured in the GSM "Overview" dialog box, which is displayed when you select the "Overview" softkey from any menu (see chapter 6.2, "Configuration Overview", on page 61).

Multiple Measurement Channels and Sequencer Function

When you activate an application, a new measurement channel is created which determines the measurement settings for that application. The same application can be activated with different measurement settings by creating several channels for the same application.

The number of channels that can be configured at the same time depends on the available memory on the instrument.

Only one measurement channel can be active at any time. However, in order to perform the configured measurements consecutively, a Sequencer function is provided.

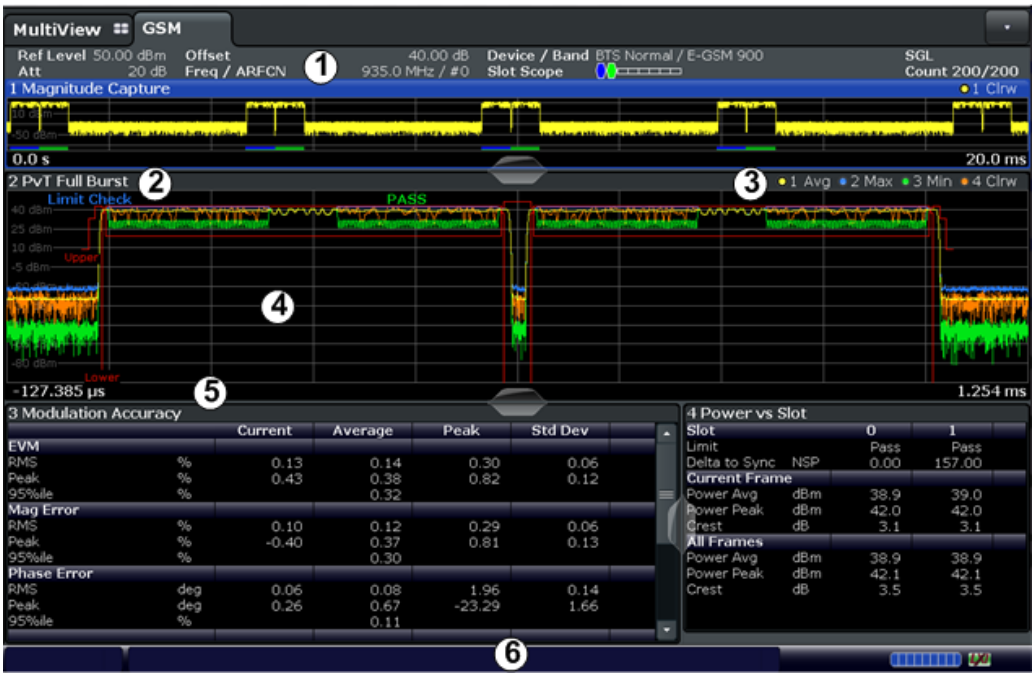
When the Sequencer is activated, the measurements configured in the currently active channels are performed one after the other in the order of the tabs. The currently active measurement is indicated by a ⚙ symbol in the tab label. The result displays of the individual channels are updated in the tabs (including the "MultiView") as the measurements are performed. Sequential operation itself is independant of the currently *displayed* tab.

See also the note on using the Sequencer function in MSRA operating mode in chapter 5.16, "GSM in MSRA Operating Mode", on page 56.

For details on the Sequencer function see the R&S FSW User Manual.

2.2 Understanding the Display Information

The following figure shows a measurement diagram during analyzer operation. All different information areas are labeled. They are explained in more detail in the following sections.



1 = Channel bar for firmware and measurement settings
2+3 = Window title bar with diagram-specific (trace) information
4 = Diagram area
5 = Diagram footer with diagram-specific information, depending on measurement
6 = Instrument status bar with error messages, progress bar and date/time display

MSRA operating mode

In MSRA operating mode, additional tabs and elements are available. An orange background behind the measurement channel tabs indicates that you are in MSRA operating mode.

For details on the MSRA operating mode see chapter 5.16, "GSM in MSRA Operating Mode", on page 56 and the R&S FSW MSRA User Manual.

Channel bar information

In the GSM application, the R&S FSW shows the following settings:

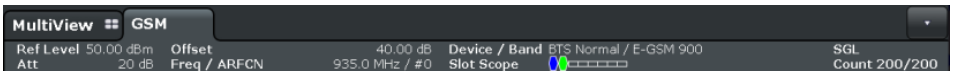


Table 2-1: Information displayed in the channel bar in the GSM application

Ref Level	Reference level
(m.+el.) Att	Mechanical and electronic RF attenuation
Offset	Reference level offset (if available)
Freq / ARFCN	Center frequency for the GSM signal / Absolute Radio Frequency Channel Number (if available)
Device / Band	Device type and frequency band used by the DUT as defined in the Signal Description

Slot Scope	Minimized visualization of the frame configuration and slots to be measured (see chapter 5.6, "Defining the Scope of the Measurement", on page 40)
SGL	The sweep is set to single sweep mode.
Count	Number of frames already evaluated / Total number of frames required for statistical evaluation (Statistic Count) (For Statistic Count > 1)
TRG	Trigger source (if not "Free Run") and used trigger bandwidth (for IF, RF, IP power triggers) or trigger offset (for external triggers)

In addition, the channel bar also displays information on instrument settings that affect the measurement results even though this is not immediately apparent from the display of the measured values (e.g. trigger settings). This information is displayed only when applicable for the current measurement. For details see the R&S FSW Getting Started manual.

Window title bar information

For each diagram, the header provides the following information:

Fig. 2-1: Window title bar information in the Pulse application

1 = Window number
2 = Window type
3 = Trace color
4 = Trace number
6 = Trace mode

Diagram footer information

The diagram footer (beneath the diagram) contains the start and stop values for the displayed time, frequency or symbol range.

Status bar information

Global instrument settings, the instrument status and any irregularities are indicated in the status bar beneath the diagram. Furthermore, the progress of the current operation is displayed in the status bar.

3 About the Measurement

A basic GSM measurement in the R&S FSW GSM application includes a power vs time and a spectrum measurement, as well as modulation accuracy (e.g. EVM, phase error) for a GSM signal as defined by the relevant 3GPP standards. The I/Q data from the GSM signal applied to the RF input of the R&S FSW is captured for a specified measurement time. This data is demodulated and synchronized with a reference signal to identify the individual frames and slots. The slots of interest are then analyzed in order to display the spectral and power results either graphically or numerically, and to calculate the modulation parameters.

The standard distinguishes between single-slot and multi-slot measurements. Single-slot measurements analyze one slot - referred to as the Slot to measure - within the GSM frame (which consists of 8 slots in total). Modulation-specific parameters such as the phase error, EVM, or spectrum due to modulation are determined. Multi-slot measurements analyze a slot scope of up to 8 consecutive slots, each of which has different burst modulation characteristics. For example, power vs time limit checks are performed over a fully occupied GSM frame, or the spectrum due to transient measurements is determined.

Statistical evaluation of several measurements is also possible. Finally, the GSM measurement results can be exported to other applications.

4 Measurement Results

The data that was captured by the R&S FSW GSM application can be evaluated using various different methods. All evaluation methods available for the GSM measurement are displayed in the selection bar in SmartGrid mode.

To activate SmartGrid mode, do one of the following:

-

  Select the "SmartGrid" icon from the toolbar.
- Select the "Display" button in the configuration "Overview".
- Select the "Display Config" softkey from the MEAS CONFIG menu.
- Press the MEAS key.

For details on working with the SmartGrid see the R&S FSW Getting Started manual.

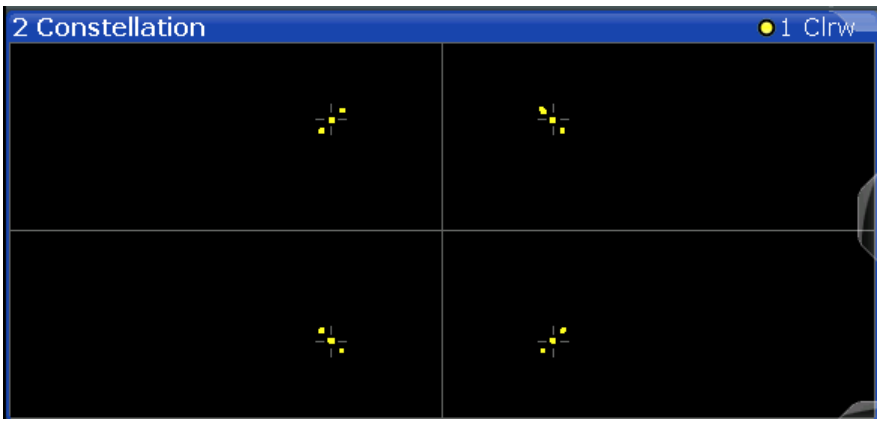
By default, the GSM measurement results are displayed in the following windows:

- Magnitude Capture
- PvT Full Burst
- Modulation Accuracy
- Power vs Slot

The following evaluation methods are available for GSM measurements:

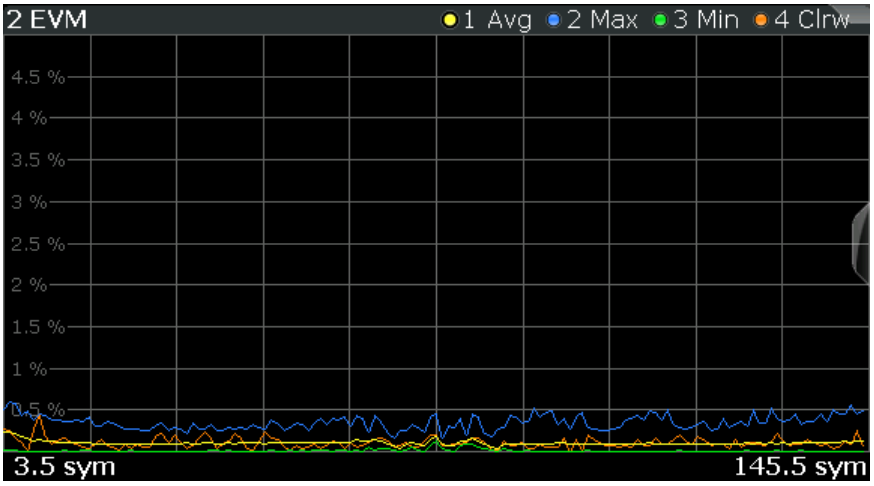
Constellation....15
EVM....16
Magnitude Capture....16
Magnitude Error....17
Marker Table....18
Modulation Accuracy....18
Modulation Spectrum Graph....20
Modulation Spectrum Table....22
Phase Error....23
Power vs Slot....24
PvT Full Burst....25
Transient Spectrum Graph....27
Transient Spectrum Table....28
Trigger to Sync Graph....29
Trigger to Sync Table....30

Constellation
The complex source signal is displayed as an X/Y diagram. The application analyzes the specified slot over the specified number of bursts.



Remote command:
LAY:ADD? '1',RIGH,CONS, see LAYout:ADD[:WINDow]? on page 201

EVM
Displays the error vector magnitude over time for the Slot to Measure.



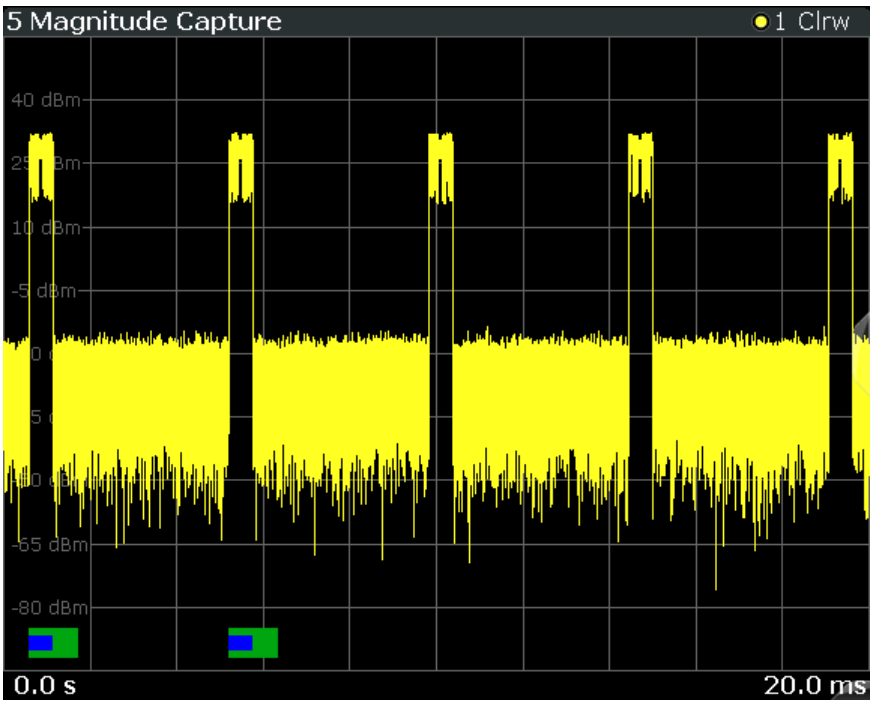
Remote command:
LAY:ADD:WIND '2',RIGH,ETIMe see LAYout:ADD[:WINDow]? on page 201
Results:
TRACe<n>[:DATA]? on page 221

Magnitude Capture
Displays the power vs. time trace of the captured I/Q data.

Pre-trigger samples are not displayed.

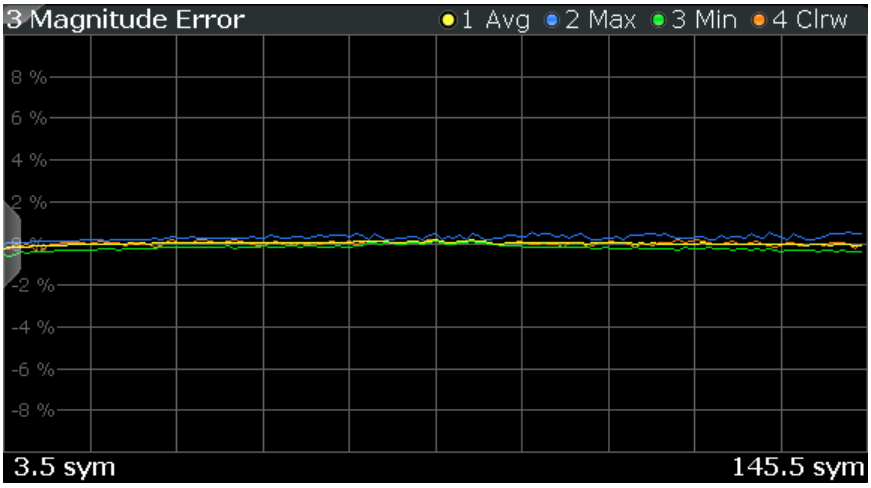
The analyzed *slot scope* (1 to 8 slots of a single GSM frame) are indicated by a green bar, the single Slot to Measure by a blue bar at the bottom of the diagram.

For details see chapter 5.6, "Defining the Scope of the Measurement", on page 40.



Remote command:
LAY:ADD:WIND '2',RIGH,MCAP see LAYout:ADD[:WINDow]? on page 201
Results:
FETCh:MCAPture:SLOTs:SCOPe on page 226
FETCh:MCAPture:SLOTs:MEASure? on page 226
TRACe<n>[:DATA]? on page 221

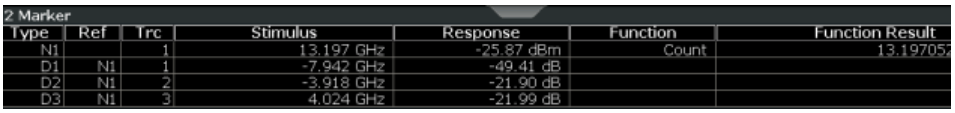
Magnitude Error
Displays the magnitude error over time for the Slot to Measure.



Remote command:
LAY:ADD:WIND '2',RIGH,MERR see LAYout:ADD[:WINDow]? on page 201
Results:
TRACe<n>[:DATA]? on page 221

Marker Table
Displays a table with the current marker values for the active markers.

This table may be displayed automatically if configured accordingly (see "Marker Table Display" on page 113).



2 Marker

Type	Ref	Trc	Stimulus	Response	Function	Function Result
N1		1	13.197 GHz	-25.87 dBm	Count	13.19705
D1	N1	1	-7.942 GHz	-49.41 dB		
D2	N1	2	-3.918 GHz	-21.90 dB		
D3	N1	3	4.024 GHz	-21.99 dB		

Remote command:
`LAY:ADD? '1',RIGH, MTAB`, see `LAYout:ADD[:WINDow]?` on page 201
Results:
`CALCulate<n>:MARKer<m>:X` on page 254
`CALCulate<n>:MARKer<m>:Y?` on page 254

Modulation Accuracy
Displays the numeric values of the fundamental modulation characteristics of the signal to be analyzed in the vector (I/Q) domain: error vector magnitude (EVM), magnitude and phase error, IQ imbalance, etc.

3 Modulation Accuracy

		Current	Average	Peak	Std Dev
EVM					
RMS	%	13.43	13.99	14.55	0.79
Peak	%	24.73	26.08	27.43	1.91
95%ile	%		25.11		
Mag Error					
RMS	%	11.90	12.34	12.79	0.63
Peak	%	24.73	26.08	27.43	1.91
95%ile	%		25.11		
Phase Error					
RMS	deg	3.59	3.66	3.74	0.11
Peak	deg	6.32	6.46	6.60	0.20
95%ile	%		6.12		
Origin Offset Suppression	dB	47.76	45.96	44.69	2.17
I/Q Offset	%	0.41	0.50	0.58	0.12
I/Q Imbalance	%	0.52	0.66	0.80	0.20
Frequency Error	Hz	16911.34	16912.68	16914.01	1.89
Slot Power	dBm	-1.10	-1.10	-1.10	0.00
Amplitude Droop	dB	0.00	0.34	0.68	0.48

The following modulation parameters are determined:

Table 4-1: Modulation accuracy parameters

Parameter	Description	SCPI query for result value

EVM	Error vector magnitude for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all EVM results for all frames in entire measurement fall
		`READ:BURSt[:MACCuracy][:EVM]:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy][:EVM]:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:EVM?`

Mag Error	Magnitude error for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all Magnitude Error results for *all frames* in entire measurement fall
		`READ:BURSt[:MACCuracy]:MERRor:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy]:MERRor:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:MERRor?`

Phase Error	Phase error for the Slot to Measure
	RMS and peak error values for the *current* frame, in percent
	95%ile: error value (in percent) below which 95% of all Phase Error results for *all frames* in entire measurement fall
		`READ:BURSt[:MACCuracy]:PERRor:PEAK:<Resulttype>?`
		`READ:BURSt[:MACCuracy]:PERRor:RMS:<Resulttype>?`
		`READ:BURSt[:MACCuracy]PERCentile:PERRor?`

Origin Offset Suppression [dB]	Origin offset suppression for the demodulated signal in the Slot to Measure; Indicates the suppression of the DC carrier; the higher the suppression, the better the DUT	`READ:BURSt[:MACCuracy]:OSUPpress:<Resulttype>?`
I/Q Offset [%]	I/Q offset for the demodulated signal in the Slot to Measure	`READ:BURSt[:MACCuracy]:IQOFfset:<Resulttype>?`
I/Q Imbalance [%]	A measure for gain imbalances and quadrature errors between the inplace and quadrature components of the signal.	`READ:BURSt[:MACCuracy]:IQIMbalance:<Resulttype>?`
Frequency Error [Hz]	Frequency error of the center frequency currently measured in the Slot to Measure	`READ:BURSt[:MACCuracy]:FERRor:<Resulttype>?`
Burst Power [dBm]	Average power measured in the slot	`READ:BURSt[:MACCuracy]:BPOWer:<Resulttype>?`
Amplitude Droop [dB]	Indicates how much the amplitude decreases over a measured slot	`READ:BURSt[:MACCuracy]:ADRoop:<Resulttype>?`

The R&S FSW GSM application also performs statistical evaluation over a specified number of results (see "Statistic Count" on page 93). To do so, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count". The default value is 200 in accordance with the GSM standard.

For each parameter, the following results are displayed:

Table 4-2: Calculated summary results

Result type	Description	SCPI query for result value
Current	Value for currently measured frame only	`READ:BURSt[:MACCuracy]:<Parameter>:CURRent?`
Average	Linear average value of "Current" results from the specified number of frames **Exception**: The average of the "Origin Offset Suppression" is the linear average of the power ratio, converted to dBm subsequently	`READ:BURSt[:MACCuracy]:<Parameter>:AVERage?`
Peak	Maximum value of "Current" results from specified number of frames **Exception**: The peak of the "Origin Offset Suppression" is the *minimum* value, as this represents the worst case, which needs to be detected	`READ:BURSt[:MACCuracy]:<Parameter>:MAXimum?`
Std Dev	Standard deviation of "Current" results for specified number of frames	`READ:BURSt[:MACCuracy]:<Parameter>:SDEViation?`

Remote command:
`LAY:ADD:WIND '2',RIGH,MACC` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`READ:BURSt[:MACCuracy]:ALL` on page 229
chapter 11.6.4, "Modulation Accuracy Results", on page 227

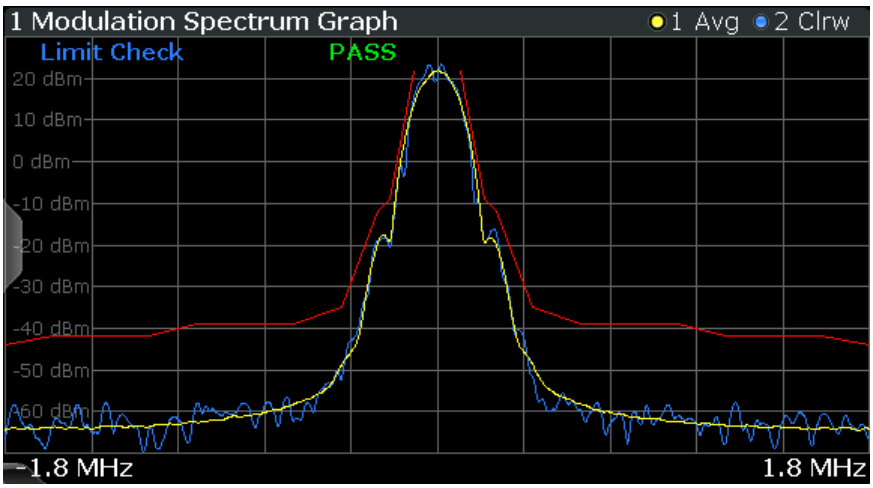
Modulation Spectrum Graph

The modulation spectrum evaluates the power vs frequency trace of a certain part of the burst (50 to 90 % of the useful part, excluding the training sequence TSC) by measuring the average power in this part over several frames at certain fixed frequency offsets.

The "Modulation Spectrum Graph" displays the measured power levels as a trace against the frequencies.

The measured values can be checked against defined limits; the limit lines are indicated as red lines in the diagram. The result of the limit check ("PASS"/"FAIL") are shown at the top of the diagram.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *either* limit is exceeded.



Note: The graphical results only provide an overview of the spectrum. For a detailed conformance check of the DUT to the GSM standard, use the "Modulation Spectrum Table" evaluation, which uses the required filtering.
The numeric results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Table" on page 22.

The following default settings are used for a "Modulation Spectrum" evaluation.

Table 4-3: Default settings for a "Modulation Spectrum" evaluation

Setting	Default
Measurement Scope	The slot selected as Slot to Measure
Averaging Configuration	Number of bursts as selected in Statistic Count
Limit Check	According to standard: Limit check of average (Avg) trace See chapter 5.12, "Limit Check for Modulation Spectrum", on page 54

Table 4-4: Frequencies and filter bandwidths in modulation spectrum measurements

Offset Frequency (kHz)	RBW (kHz)	VBW (kHz)
± 100	30	30
± 200	30	30
± 250	30	30
± 400	30	30
± 600	30	30
± 800	30	30
± 1000	30	30
± 1200	30	30
± 1400	30	30

Offset Frequency (kHz)	RBW (kHz)	VBW (kHz)
± 1600	30	30
± 1800	30 or 100	30 or 100

Remote command:
`LAY:ADD:WIND '2',RIGH,MSFD` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`TRACe<n>[:DATA]?` on page 221
`CALCulate<n>:LIMit<k>:FAIL?` on page 252

Modulation Spectrum Table
The modulation spectrum evaluates the power vs frequency trace of a certain part of the burst (50 to 90 % of the useful part, excluding the training sequence TSC) by measuring the average power in this part over several frames.

The "Modulation Spectrum Table" displays the measured power levels and their offset to the limits defined by the standard as numeric results.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *either* limit is exceeded.
Values that exceed either limit are indicated by red characters and an asterisk (*) next to the value, and a negative "Δ to Limit" value.

2 Modulation Spectrum Table

Offset	Power Negative Offsets			Power Positive Offsets		
kHz	dB	dBm	Δ to Limit	dB	dBm	Δ to Limit
100	-7.7	-0.6	8.2	-10.1	-2.9	10.6
200	-44.0	-36.9	14.0	-42.7	-35.6	12.7
250	-43.3	-36.2	10.3	-44.4	-37.2	11.4
400	-63.6	-56.4	3.6	-61.4	-54.3	1.4
600	-63.0	-55.9	3.0	-63.0	-55.9	3.0
800	-62.2	-55.1	2.2	-63.5	-56.3	3.5
1000	-65.9	-58.8	5.9	-62.6	-55.4	2.6
1200	-65.0	-57.9	2.0	-63.8	-56.7	0.8
1400	-63.7	-56.6	0.7	-65.8	-58.6	2.8
1600	*-61.3	*-54.1	-1.7	*-62.6	*-55.4	-0.4
1800	*-61.4	*-54.2	-8.8	*-61.7	*-54.5	-8.5
3000	*-57.5	*-50.4	-7.5	*-59.3	*-52.1	-5.7
6000	*-59.4	*-52.2	-12.8	*-56.5	*-49.3	-15.7

Note: The graphical results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Graph" on page 20.

The following values are displayed:

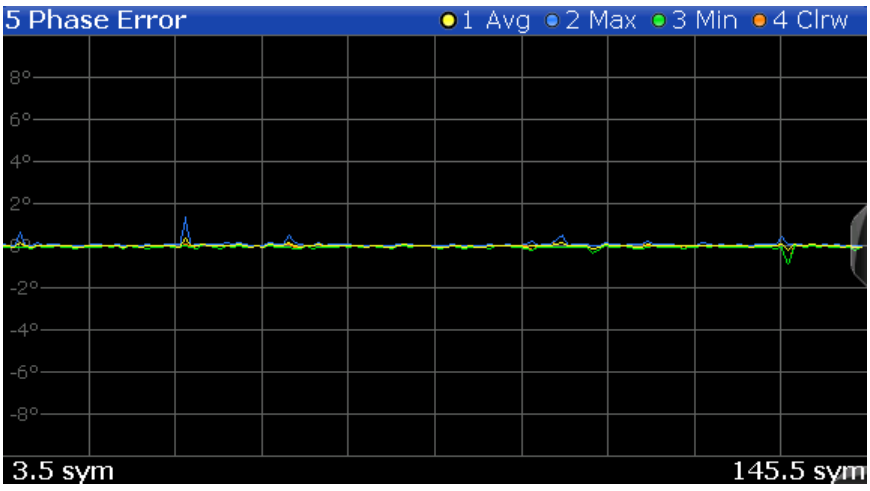
Table 4-5: Modulation spectrum results

Result	Description
Offset [kHz]	Fixed frequency offsets (from the center frequency) at which power is measured
Power Negative Offsets	Power at the frequency offset to the left of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits
Power Positive Offsets	Power at the frequency offset to the right of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits

Note: "Normal" vs "Wide" Modulation Spectrum measurements.
In previous R&S signal and spectrum analyzers, both a "normal" and a "wide" modulation spectrum were available for GSM measurements. In the R&S FSW GSM application, only one evaluation is provided. The frequency range of the frequency list, however, can be configured to be "wider" or "narrower" (see "Modulation Spectrum Table: Frequency List" on page 104). The RBW and VBW are then adapted accordingly.

Remote command:
`LAY:ADD:WIND '2',RIGH,MST` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`READ:SPECtrum:MODulation[:ALL]` on page 238
`READ:SPECtrum:MODulation:REFerence[:IMMediate]?` on page 239

Phase Error
Displays the phase error over time.



The following default settings are used for a "Phase Error vs Time" measurement.

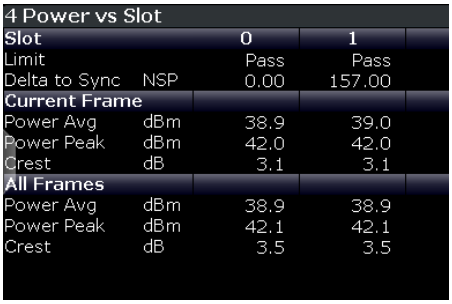
Setting	Default
Measurement Scope	The slot selected as Slot to Measure
Averaging Configuration	Number of frames as selected in Statistic Count
Limit Check	None

Remote command:
`LAY:ADD:WIND '2',RIGH,PERR` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`TRACe<n>[:DATA]?` on page 221

Power vs Slot

Displays the power per slot in the current frame and over all frames. The result of the (Power vs Time) limit check is also indicated.

Note: The power is measured for inactive slots, but not for slots outside the slot scope (see chapter 5.6, "Defining the Scope of the Measurement", on page 40).


4 Power vs Slot
Slot 0 1
Limit Pass Pass
Delta to Sync NSP 0.00 157.00
Current Frame
Power Avg dBm 38.9 39.0
Power Peak dBm 42.0 42.0
Crest dB 3.1 3.1
All Frames
Power Avg dBm 38.9 38.9
Power Peak dBm 42.1 42.1
Crest dB 3.5 3.5

The following power values are determined:

Table 4-6: Measured power values for Power vs Slot results

Value	Description	SCPI query for result value
Slot	Analyzed slot number in frame(s) [0..7]	
PvT Limit	Power vs *Time* limit for the power vs time trace of the slot, defined by the standard	`READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?` on page 247
Delta to Sync [NSP]	The distance between the mid of the TSC and the TSC of the Slot to Measure NSP stands for Normal Symbol Period, i.e. the duration of one symbol using a normal symbol rate (approx. 3.69µs). The measured "Delta to Sync" value has a resolution of 0.02 NSP. For details see chapter 5.11, "Delta to Sync Values", on page 53.	`READ:BURSt:SPOWer:SLOT<Slot>:DELTatosync?` on page 246

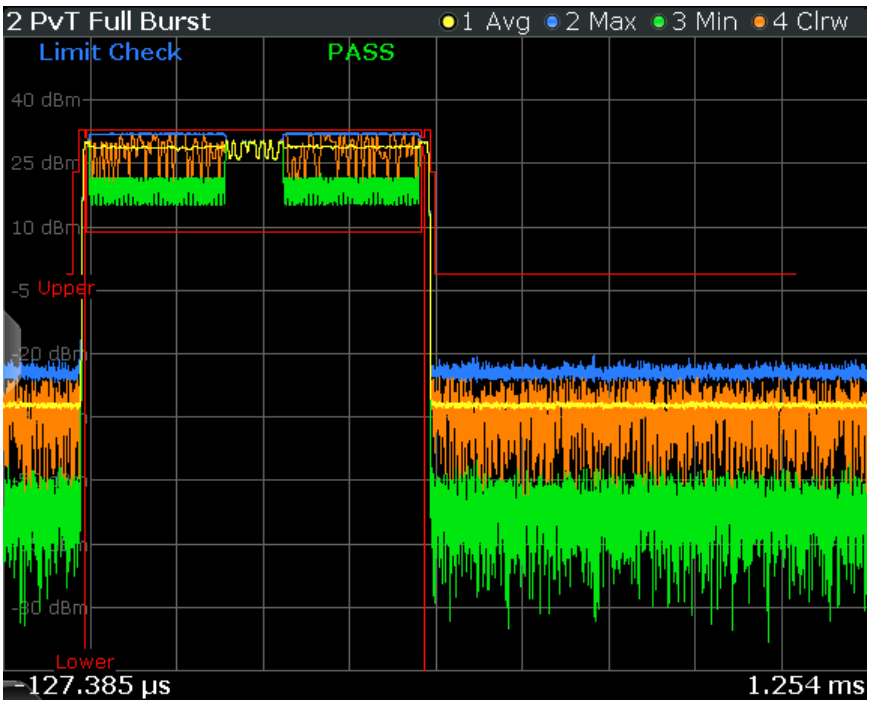
Value	Description	SCPI query for result value
Power Avg [dBm]	Average power in slot in current or all frames	`READ:BURSt:SPOWer:SLOT<Slot>:CURRent:AVERage?` on page 243 `READ:BURSt:SPOWer:SLOT<Slot>:ALL:AVERage?` on page 240
Power Peak [dBm]	Maximum power in slot in current or all frames	`READ:BURSt:SPOWer:SLOT<Slot>:CURRent:MAXimum?` on page 245 `READ:BURSt:SPOWer:SLOT<Slot>:ALL:MAXimum?` on page 242
Crest [dB]	Crest factor in slot in current or all frames, i.e. Power Peak / Power Avg	`READ:BURSt:SPOWer:SLOT<Slot>:CURRent:CRESt?` on page 244 `READ:BURSt:SPOWer:SLOT<Slot>:ALL:CRESt?` on page 241

Remote command:
`LAY:ADD:WIND '2',RIGH,PST` see `LAYout:ADD[:WINDow]?` on page 201
Results:
chapter 11.6.6, "Power vs Slot Results", on page 240

PvT Full Burst
The Power vs Time evaluation determines the power of all slots (bursts) in the selected slot scope and performs a limit check against the specified PvT mask.

The "PvT Full Burst" result display shows the trace of the power values for all bursts in the slot scope versus time. The PvT mask is indicated by red lines, and the *overall* result of the limit check is shown at the top of the diagram.

Note: The result of the Power vs Time limit check *for individual slots* is indicated in the "Power vs Slot" on page 24 evaluation.



Note: *Full burst* refers to the fact that the entire burst is displayed, including the rising and falling edges and the burst top. However, you can easily analyze the edges in more detail using the zoom functions (see chapter 7.3, "Zoom Functions", on page 116).

The following default settings are used for a "Power vs Time" evaluation.

Table 4-7: Default settings for a "Power vs Time" evaluation

Setting	Default
Measurement Scope	The slot scope defined by First Slot to measure and Number of Slots to measure
Averaging Configuration	Number of bursts as selected in Statistic Count
Limit Check	According to standard: • The maximum (Max) trace is checked agains the upper limit. • The minimum (Min) trace is checked against the lower limit. See chapter 5.14, "Limit Check for Power vs Time Results", on page 55

Remote command:

`LAY:ADD:WIND '2',RIGH,PTF` see `LAYout:ADD[:WINDow]?` on page 201

Results:

`TRACe<n>[:DATA]?` on page 221

`TRACe<n>[:DATA]:X?` on page 221

`CALCulate<n>:LIMit<k>:FAIL?` on page 252

Transient Spectrum Graph

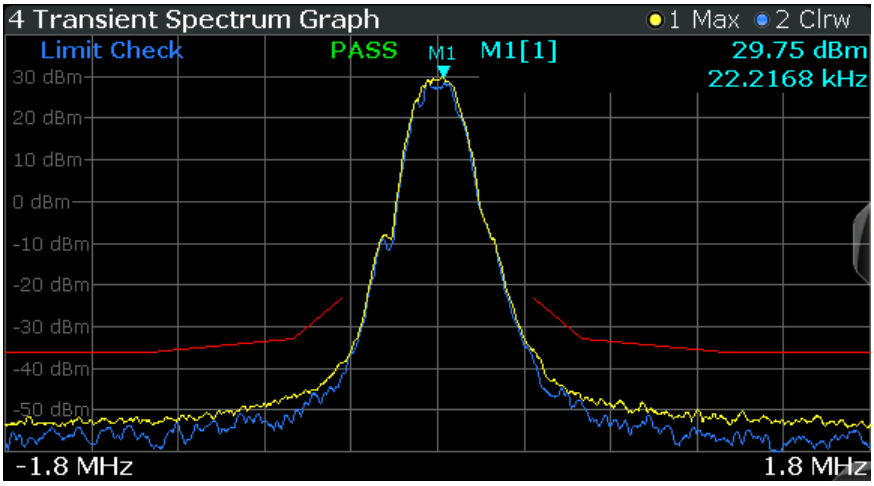
The transient spectrum is very similar to the modulation spectrum evaluation; it evaluates the power vs frequency trace by measuring the power over several frames. However, as opposed to the modulation spectrum evaluation, the entire slot scope (defined by the Number of Slots to measure and the First Slot to measure) is evaluated in each frame, including the rising and falling burst edges, not just the useful part in the Slot to Measure.

Furthermore, the number of fixed frequency offsets is lower, and the peak power is evaluated rather than the average power, as this measurement is used to determine irregularities.

The "Transient Spectrum Graph" displays the measured power levels as a trace against the frequencies for the specified slots.

The measured values can be checked against defined limits; the limit lines are indicated as red lines in the diagram. The result of the limit check ("PASS"/"FAIL") is shown at the top of the diagram.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *either* limit is exceeded.



Note: The graphical results only provide an overview of the spectrum. For a detailed conformance check of the DUT to the GSM standard, use the "Transient Spectrum Table" evaluation, which uses the required filtering.
The numeric results of the modulation spectrum evaluation are displayed in the "Modulation Spectrum Table" on page 22.

The following default settings are used for "Transient Spectrum" measurements.

Setting	Default
Measurement Scope	The slot scope defined by Number of Slots to measure and the First Slot to measure in the "Demodulation Settings" (see chapter 6.7.1, "Slot Scope", on page 95).
Averaging Configuration	Number of frames as selected in Statistic Count
Limit Check	Limit check of maximum (Max) trace See chapter 5.13, "Limit Check for Transient Spectrum", on page 54

Remote command:
`LAY:ADD:WIND '2',RIGH,TSFD` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`TRACe<n>[:DATA]?` on page 221
`CALCulate<n>:LIMit<k>:FAIL?` on page 252

Transient Spectrum Table
The transient spectrum evaluates the power vs frequency trace of the slot scope by measuring the power in these slots over several frames.

For details see "Transient Spectrum Graph" on page 27.

The "Transient Spectrum Table" displays the measured power levels and their offset to the limits defined by the standard as numeric results.

Note: The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *either* limit is exceeded.
Values that exceed either limit are indicated by red characters and an asterisk (*) next to the value, and a negative "Δ to Limit" value.

2 Transient Spectrum Table

Offset	Power Negative Offsets			Power Positive Offsets		
kHz	dB	dBm	Δ to Limit	dB	dBm	Δ to Limit
400	*-40.0	*-22.1	-13.9	*-40.4	*-22.5	-13.5
600	*-45.5	*-27.6	-8.4	*-45.5	*-27.6	-8.4
1200	-59.1	-41.2	5.2	-56.6	-38.7	2.7
1800	-61.6	-43.7	7.7	-61.7	-43.8	7.8

Note: The graphical results of the transient spectrum evaluation are displayed in the "Transient Spectrum Graph" on page 27.

The following values are displayed:

Table 4-8: Modulation spectrum results

Result	Description
Offset [kHz]	Fixed frequency offsets (from the center frequency) at which power is measured
Power Negative Offsets	Power at the frequency offset to the left of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits
Power Positive Offsets	Power at the frequency offset to the right of the center frequency Levels are provided as: [dB]: relative power level [dBm]: absolute power level Δ to Limit: power difference to limit defined in standard; negative values indicate the power exceeds at least one of the limits

Remote command:
`LAY:ADD:WIND '2',RIGH,TST` see `LAYout:ADD[:WINDow]?` on page 201
Results:
`READ:SPECtrum:SWITching[:ALL]?` on page 248
`READ:SPECtrum:SWITching:REFerence[:IMMediate]` on page 249

Trigger to Sync Graph

The Trigger to Sync measurement determines the time between an *external* trigger event and the middle of the TSC of the Slot to Measure. Only one result per data capture is provided. Therefore, it is useful to perform several data captures and average the results to obtain an accurate value (see "Statistic Count" on page 93).

Both graphical and numeric (table) results are available. While the graphical results are mainly used to determine the required measurement settings, the numeric results provide the actual trigger to sync value, including statistical evaluation (see "Trigger to Sync Table" on page 30).

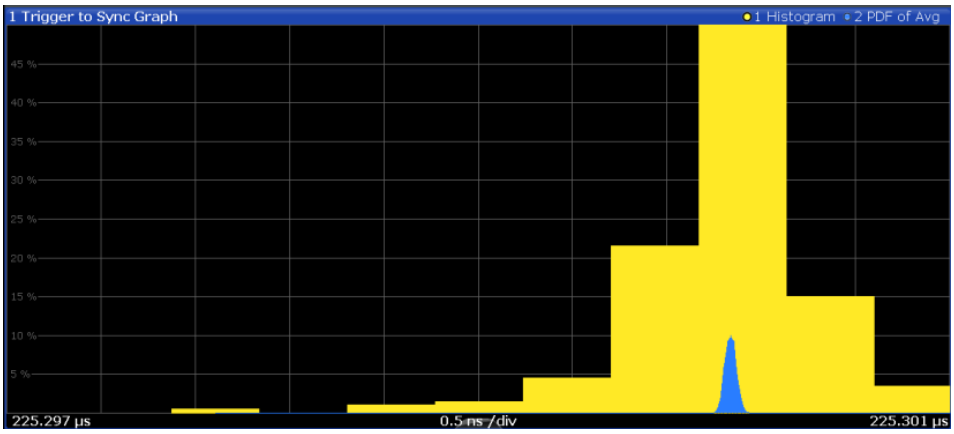


Fig. 4-1: Trigger to Sync Graph

The Trigger to Sync diagram shows two traces:

- **Trace1**: a **histogram** shows the probability density function (PDF) of *all measured* Trigger to Sync values. Obviously, the histogram can only provide reasonable results if several I/Q captures are performed and considered. In an ideal case (assuming no noise), the histogram would be a rectangle over the sampling time.
  The histogram is helpful to determine the number of samples to be averaged in order to obtain the required time resolution. The more samples are averaged, the more the graph becomes rectangular, and the higher the resolution becomes. However, the error of the DUT increases, as well.
- **Trace2**: the second trace is superimposed on the histogram and visualizes the probability density function (PDF) of the *average* Trigger to Sync value and the standard deviation as provided in the Trigger to Sync table. This trace helps you judge the reliability of the averaged values in the table. The lower this trace, the less the individual values deviate from the averaged result. if this trace is too high, increase the Statistic Count.

Note: The x-axis of the histogram indicates the individual Trigger to Sync values. Thus, the scaling must be very small, in the range of ns. However, since the value range, in particular the start value, of the possible results is not known, the x-axis must be adapted to the actual values after a number of measurements have taken place. This is done using the adaptive data size setting (see "Adaptive Data Size" on page 106). This setting defines how many measurements are performed before the x-axis is adapted to the measured values, and then fixed to that range.

Remote command:
`LAY:ADD? '1',RIGH,TGSG`, see `LAYout:ADD[:WINDow]?` on page 201
`DISPlay:WINDow:TRACe1:MODE WRITe` (for Histogram, see `DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 207)
`DISPlay:WINDow:TRACe2:MODE PDFavg` (for PDF of average, see `DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 207)
Results:
`TRACe<n>[:DATA]?` on page 221
`TRACe<n>[:DATA]:X?` on page 221

Trigger to Sync Table

The Trigger to Sync measurement determines the time between an *external* trigger event and the middle of the TSC of the Slot to Measure. Only one result per data capture is provided. Therefore, it is useful to perform several data captures and average the results to obtain an accurate value (see "Statistic Count" on page 93).

Both graphical and numeric (table) results are available. While the graphical results are mainly used to determine the required measurement settings (see "Trigger to Sync Graph" on page 29), the numeric results provide the actual trigger to sync value, including statistical evaluation.

2 Trigger to Sync Table

	Current	Average	Min	Max	Std Dev
Trigger to Sync us	225.30005	225.30006	225.29788	225.30124	0.00042

Fig. 4-2: Trigger to Sync table

The Trigger to Sync table shows the following values:

Value	Description
Current	Trigger to Sync value for current measurement in µs
Average	Trigger to Sync value averaged over the Statistic Count number of measurements
Min	Minimum Trigger to Sync value in the previous Statistic Count number of measurements
Max	Maximum Trigger to Sync value in the previous Statistic Count number of measurements
Std Dev	Standard deviation of the individual Trigger to Sync values to the average value

Remote command:
`LAY:ADD? '1',RIGH,TGST`, see `LAYout:ADD[:WINDow]?` on page 201
Results:
chapter 11.6.8, "Trigger to Sync Results", on page 250

5 Basics on GSM Measurements

Some background knowledge on basic terms and principles used in GSM measurements is provided here for a better understanding of the required configuration settings.

5.1 Relevant Digital Standards

The measurements and the physical layer – the layer of the GSM network on which modulation, transmission of RF signals, reception of RF signals, and demodulation take place – is defined in the standards:

Table 5-1: GSM standards

• 3GPP TS 45.004	Details on Modulation
• 3GPP TS 45.005	General measurement specifications and limit values
• 3GPP TS 45.010	Details on Synchronization and Timing
• 3GPP TS 51.010	Detailed measurement specifications and limit values for mobile stations (MS)
• 3GPP TS 51.021	Detailed measurement specifications and limit values for base transceiver stations (BTS)

5.2 Short introduction to GSM (GMSK, EDGE and EDGE Evolution)

The GSM (Global System for Mobile Communication) standard describes the GSM mobile radio network that is in widespread use today. In a first step to enhance this network, 8PSK modulation has been defined in addition to the existing GMSK (Gaussian Minimum Shift Keying) modulation. With 8PSK, the mobile or base station operates in the EDGE mode. While the 8PSK modulation transmits 3 bits within a symbol, GMSK can only transmit 1 bit within a symbol.

In a second step to enhance this network, higher symbol rate (HSR), QPSK, 16QAM, and 32QAM modulation, narrow and wide pulse shapes for the Tx filter have been defined. Here, EDGE Evolution and EGPRS2 are synonyms for this second enhancement.

This means that GSM includes different modes: GMSK, EDGE and EDGE Evolution. The terms EDGE and EDGE Evolution are used here only when there are significant differences between the modes. In all other cases, the term GSM is used.

Time domain vs frequency domain

A TDMA (Time Division Multiple Access) and FDMA (Frequency Division Multiple Access) scheme is used to transfer data in the GSM network. This means that the digital information is transmitted discretely in the time domain (mainly used to distinguish between different users) as well as in the frequency domain (mainly used to distinguish between BTS).

Slots and frames

The time domain is divided into *slots* with a duration of 576.923 µs (exactly: 3/5200 s). 8 slots (numbered 0 to 7) are combined into 1 *frame* with a duration of approximately 4.6154 ms (exactly: 3/650 s).

Multiframes and superframes

Frames can be grouped into a multiframe consisting of either 26 (for support traffic and associated control channels) or 51 (for all other purposes) frames. Multiframes can be grouped to superframes consisting of either 51 26-frame or 26 51-frame multiframes.

Multiframes and superframes are not of relevance for the physical measurements on the GSM system and thus not discussed in detail here.

A mobile phone, therefore, does not communicate continuously with the base station; instead, it communicates discretely in individual slots assigned by the base station during connection and call establishment. In the simplest case, 8 mobiles share the 8 slots of a frame (TDMA).

Frequency bands and channels

The frequency range assigned to GSM is divided into frequency bands, and each band, in turn, is subdivided into channels.

Each frequency channel is identified by its center frequency and a number, known as the ARFCN (Absolute Radio Frequency Channel Number), which identifies the frequency channel within the specific frequency band. The GSM channel spacing is 200 kHz.

Communication between a mobile and a base station can be either frequency-continuous or frequency-discrete – distributed across various frequency channels (FDMA). In the standard, the abbreviation "SFH" (slow frequency hopping) is used to designate the latter mode of communication.

Uplink and downlink

Base stations and mobiles communicate in different frequency ranges; the mobile sends in the "uplink" (UL), and the base station in the "downlink" (DL).

The frequencies specified in the standard plus their channel numbers (ARFCN) are shown in the figure and table below.

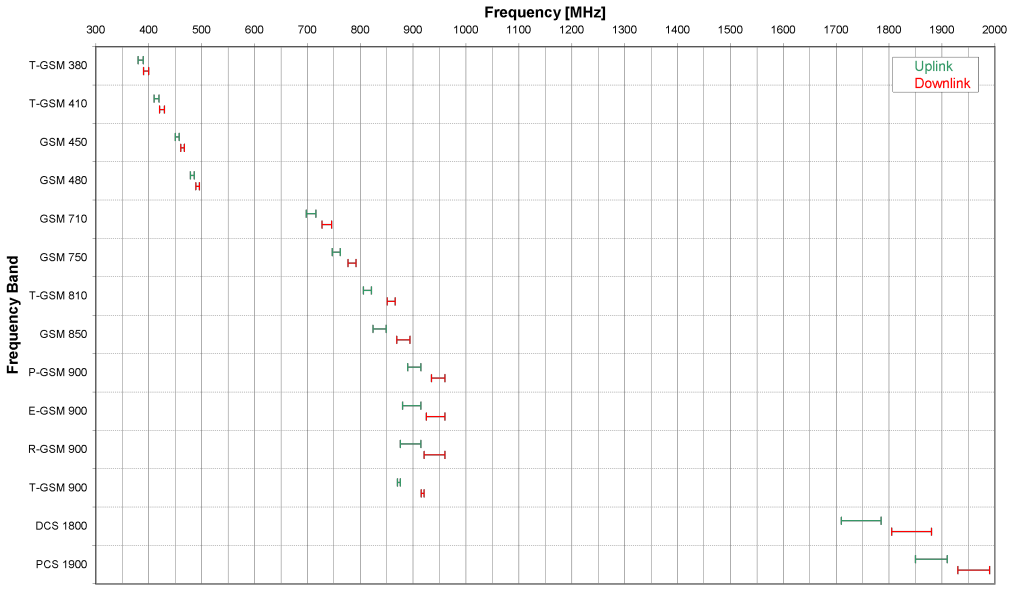


Fig. 5-1: The frequencies specified in the GSM standard

Table 5-2: Frequencies and channel numbers (ARFCN) in the GSM standard

Band Class	UL [MHz] Frequency		DL [MHz] Frequency		Frequency Middle		Band	UL-DL Shift	ARFCN	
	Low.	Up.	Low.	Up.	UL	DL			Range 1	Range 2
T-GSM 380	380.2	389.8	390.2	399.8	385.0	395.0	10 MHz		0 … 48 [1]	–
T-GSM 410	410.2	419.8	420.2	429.8	415.0	425.0	10 MHz		0 … 48 [1]	–
GSM 450	450.4	457.6	460.4	467.6	454.0	464.0	10 MHz		259 … 293	–
GSM 480	478.8	486.0	488.8	496.0	482.4	492.4	10 MHz		306 … 340	–
GSM 710	698.0	716.0	728.0	746.0	707.0	737.0	30 MHz		0 … 90 [1]	–
GSM 750	747.0	762.0	777.0	792.0	754.5	784.5	30 MHz		438 … 511	–
T-GSM 810	806.0	821.0	851.0	866.0	813.5	858.5	45 MHz		0 … 75 [1]	–
GSM 850	824.0	849.0	869.0	894.0	836.5	881.5	45 MHz		128 … 251	–
P-GSM 900	890.0	915.0	935.0	960.0	902.5	947.5	45 MHz		1 … 124	–

Band Class	UL [MHz]	Frequency	DL [MHz]	Frequency	Frequency Middle	Band	UL-DL Shift	ARFCN	
	Low.	Up.	Low.	Up.	UL	DL		Range 1	Range 2
E-GSM 900	880.0	915.0	925.0	960.0	897.5	942.5	45 MHz	0 … 124	975 … 1023
R-GSM 900	876.0	915.0	921.0	960.0	895.5	940.5	45 MHz	0 … 124	955 … 1023
T-GSM 900	870.4	876.0	915.4	921.0	873.2	918.2	45 MHz	0 … 28 [1]	–
DCS 1800	1710.0	1785.0	1805.0	1880.0	1747.5	1842.5	95 MHz	512 … 885	–
PCS 1900	1850.0	1910.0	1930.0	1990.0	1880.0	1960.0	80 MHz	512 … 810	–

[1] For these frequency bands, there is no fixed ARFCN to frequency assignment, instead it is calculated with a formula taking an OFFSET parameter which is signaled by a higher layer of the network. The given ARFCNs assume an OFFSET value of 0.

Modulation modes

Different modulation modes are used in the GSM mobile radio network. The original GSM modulation is GMSK, with the normal symbol rate (NSR) of approximately 270.833 ksymb/s (exactly: 1625/6 ksymb/s). This corresponds to a bit rate of 270.833 kbit/s. The details are specified in chapter 2 of "3GPP TS 45.004" (see table 5-1).

The 8PSK (Phase Shift Keying) modulation, which is used within EDGE, was introduced to increase the data rate on the physical link. It uses the same symbol rate (the normal symbol rate) as GMSK (270.833 ksymb/s), but has a bit rate of 3 × 270.833 kbit/s (exactly: 812.5 kbit/s).

In this method, three bits represent a symbol. The details are specified in chapter 3 "3GPP TS 45.004" (see table 5-1).

The 16QAM and 32QAM (Quadrature Amplitude Modulation) modulation, which are used in EDGE Evolution, were introduced to further increase the data rate on the physical link. They use the normal symbol rate (270.833 ksymb/s), but have bit rates of 4 × 270.833 kbit/s or 5 × 270.833 kbit/s, respectively. The details are specified in chapter 4 "3GPP TS 45.004" (see table 5-1).

The QPSK, 16QAM and 32QAM modulation with a higher symbol rate, which are used in EDGE Evolution, were introduced to further increase the data rate on the physical link. They use a higher symbol rate (325 ksymb/s), but have bit rates of 2 × 325 kbit/s, 4 × 325 kbit/s or 5 × 325 kbit/s, respectively. The details are specified in chapter 5 "3GPP TS 45.004" (see table 5-1).

The figure below shows the modulation spectrum for both GMSK and 8PSK.

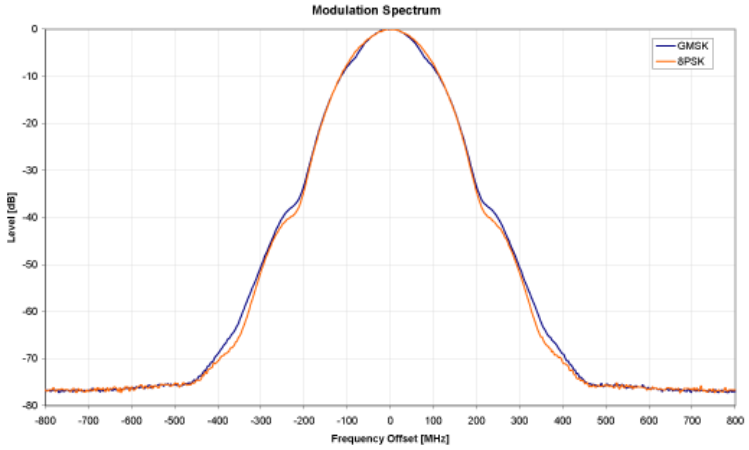


Fig. 5-2: GMSK and 8PSK modulation spectrum

Increasing the bandwidth - multiple slots (GPRS, HSCSD)

The customers' demand for higher telecommunication speeds increases the demand for bandwidth. Therefore, the GSM standard has to evolve constantly. An example of this development is the introduction of the EDGE/EDGE Evolution specification and the GPRS/EGPRS2 and HSCSD modes.

Until now, each mobile could use only one slot per frame, but the new HSCSD (High Speed Circuit Switched Data) and GPRS (General Packet Radio Service) methods will allow permanent assignment of more than one slot per mobile, plus dynamic utilization of multiple slots.

The concept behind GPRS is dynamic assignment of up to 8 slots to each mobile for data transmission, depending on demand (and availability in the network).

HSCSD allows permanent assignment of up to 4 slots to a mobile.

Normal and higher symbol rates

The modulation modes GMSK, QPSK, 8PSK, 16QAM and 32QAM can be used with either normal or higher symbol rate and different Tx filters.

What is significant for the R&S FSW GSM application in this respect is that the mobile can send power on a frequency in more than one slot.

5.3 Short Introduction to VAMOS

The "Voice services over Adaptive Multi-user Channels on One Slot" (VAMOS) extension to the GSM standard allows transmission of two GMSK users simultaneously within a single time slot.

Subchannels

The standard specifies the downlink signal using Adaptive QPSK (AQPSK) modulation (see 3GPP TS 45.004), where two "subchannel" binary sequences are multiplexed to

form a single QPSK sequence. The ratio of powers for the subchannels is referred to as the "Subchannel Power Imbalance Ratio" (**SCPIR**). One of the subchannels is interpreted as interference. The value of SCPIR affects the shape of the AQPSK constellation. For an SCPIR of 0dB the constellation is square (as in "normal" QSPK), while for other values of the SCPIR the constellation becomes rectangular.

Training sequences (TSCs)

A new set of training sequences (TSCs) has also been proposed (see 3GPP TS 45.002) for GMSK signals. The previous TSCs for GMSK bursts are listed as "Set 1", while the new TSCs are listed as "Set 2". AQPSK signals can be formed using TSCs from Set 1 on the first subchannel and TSCs from either Set 1 or Set 2 on the second subchannel. In case a TSC from Set 2 is used, it should match the TSC from Set 1, i.e. TSC<n> from Set 1 on subchannel 1 should match TSC<n> from Set 2 on subchannel 2, for n = 0..7.

TSC vs "Midamble"

The terms *TSC* and *Midamble* are used synonymously in the standard. In this documentation, we use the term *TSC* to refer to the known symbol sequence in the middle of the slot.

The R&S FSW GSM application supports measurement of the following signals:

- GMSK bursts using the TSCs from Set 1 or Set 2
- AQPSK bursts with combinations of TSCs from Set 1 and 2 on the subchannels
- AQPSK bursts with a user-specified SCPIR

The following measurements of the above signals are supported:

- Power vs Time
- Demod (Modulation Accuracy, EVM vs Time, Phase Error vs Time, Magnitude Error vs Time, Constellation)
- Spectrum (modulation, transient) including limit check
- Automatic trigger offset detection

Restriction for auto frame configuration

Auto Frame configuration only detects AQPSK normal bursts where the subchannels have a TSC according to table 5-3. The SCPIR value is detected with a resolution of 1 dB. To obtain reliable measurement results on AQPSK normal bursts, compare the auto-detected slot settings with the settings of your device under test.

Table 5-3: Required subchannel - TSC assignment for AQPSK auto frame configuration

AQPSK			Subchannel 2															
			TSC j (Set 1)								TSC j (Set 2)							
			0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
Subcha	TSC i	0			x	x				x	x							
		1			x	x				x		x						

AQPSK			Subchannel 2															
			TSC j (Set 1)								TSC j (Set 2)							
			0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
nnel 1	(Set 1)	2	x	x				x					x					
		3	x	x			x							x				
		4				x			x						x			
		5			x				x							x		
		6					x	x									x	
		7	x	x														x

5.4 AQPSK Modulation

The AQPSK modulation scheme as proposed for use in GSM systems is illustrated in figure 5-3. First, the bits from two users (subchannels 1 and 2) are interleaved. The combined bit sequence is then mapped to an AQPSK constellation which depends on the SCPIR value. The AQPSK symbols are then modulated using the linearized GMSK pulse (see 3GPP TS 45.004).

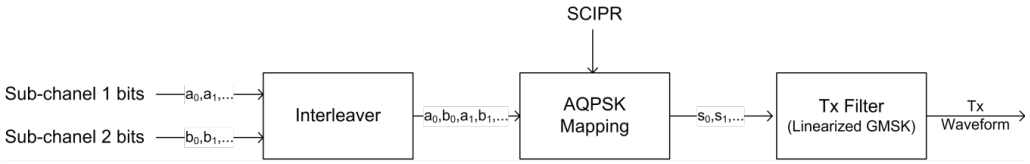


Fig. 5-3: AQPSK modulation scheme for GSM systems

The proposed AQPSK mapping (as assumed in the R&S FSW GSM application) is given in table 5-4 and illustrated in figure 5-4, where the first (leftmost) bit corresponds to subchannel 1 and the second (rightmost) bit corresponds to subchannel 2.

Table 5-4: AQPSK symbol mappings [reproduced from 3GPP TS 45.004]

Modulating bits for a_i, b_i	AQPSK symbol in polar notation s_i
(0,0)	$e^{j\alpha}$
(0,1)	$e^{-j\alpha}$
(1,0)	$-e^{-j\alpha}$
(1,1)	$-e^{j\alpha}$

The AQPSK modulation constellation diagram is shown in figure 5-4, where the value α is an angle related to the SCPIR as follows:

$SCPIR_{dB} = 20*\log_{10}[\tan(\alpha)\ ]$ dB

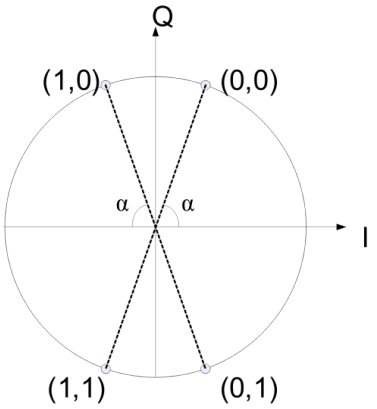


Fig. 5-4: AQPSK constellation [reproduced from 3GPP change request document GP-100275].

5.5 Trigger settings

The GSM measurements can be performed in "Free Run" (untriggered) mode; however, an external trigger or a power trigger can speed up measurements. To perform measurements the R&S FSW GSM application needs the frame start as a time reference. The R&S FSW GSM application searches for a frame start after every I/Q data acquisition. The required search effort depends on the trigger mode.

Consider the following trigger mode settings:

- In "Free Run" mode, i.e. without any trigger, the GSM application totally relies on the frame/slot configuration to find the frame start. The start of a measurement is not triggered. Once a measurement is completed, another is started immediately. For an unambiguous frame configuration, the GSM application searches for the frame start inside the captured I/Q data. This is the slowest frame search mode.
- With a "Power Trigger", the measurement is triggered by the power ramp of the received GSM bursts. Nevertheless the GSM application still relies on the frame/slot configuration to find the frame start inside the captured I/Q data. Once a measurement is completed, the GSM application waits for the next trigger event to start the next measurement. The search for the frame start is as in "Free Run" mode, except that the I/Q data capture is triggered.
- With the "External Trigger", the measurement is triggered by an external signal (connected to the "EXT TRIGGER" input of the R&S FSW). The GSM application assumes that the frame start (i.e. the "active part" in slot 0) directly follows the trigger event. An external trigger requires a correct setting of the trigger offset. The search is faster compared to the free run and power trigger modes. Use an external trigger to maximize the measurement speed or if the frame configuration is ambiguous (i.e. if the slot properties are cyclic with a cycle less than the frame duration).

Trigger source for MSRA Master

Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application. For this purpose, the trigger is considered to be in "Free Run" mode.

Refer to chapter 6.5, "Trigger Settings", on page 85 to learn more about appropriate trigger settings and to chapter 6.3, "Signal Description", on page 63 for information on the frame/slot configuration.

Refer to chapter 6.9, "Adjusting Settings Automatically", on page 107 to learn more about setting the trigger offset automatically.

5.6 Defining the Scope of the Measurement

The R&S FSW GSM application is slot-based. It can measure up to 8 consecutive GSM slots (1 frame) and store the power results for all slots ("Power vs Time" and "Power vs Slot" measurements, see "PvT Full Burst" on page 25 and "Power vs Slot" on page 24).

In previous R&S signal and spectrum analyzers, the term "burst" was used synonymously for "slot". In this documentation, we use the term "burst" when the signal behaves like a pulse, i.e. power is ramped up and down. The up ramp is referred to as the *rising edge*, the down ramp as the *falling edge*. A burst may occur within one or more slots, which is a measure of time in the captured signal. Thus, a burst may coincide with a slot, but it must not necessarily do so.

Usually only slots in which a burst is expected are of interest. Such slots are defined as *active* slots in the signal description.

Within this slot scope (defined by First Slot to measure and Number of Slots to measure), a single slot (Slot to Measure) is selected for a more detailed analysis (e.g. "Modulation Accuracy" measurement, see "Modulation Accuracy" on page 18). The Slot to Measure is required for the following reasons:

- To provide the reference power and time reference for the "Power vs Time" measurement (see "PvT Full Burst" on page 25). Typically, the masks for all slots are time-aligned according to the timing of the Slot to Measure (see "Limit Line Time Alignment" on page 102).
- All "Modulation Spectrum" results are based on the Slot to Measure (see "Modulation Spectrum Graph" on page 20). (The results of all "Transient Spectrum" diagrams are based on the slot *scope*, i.e. on the interval defined by the First Slot to measure and the Number of Slots to measure, see "Transient Spectrum Graph" on page 27).
- All results that require demodulation of one slot and statistical analysis (e.g. Modulation Accuracy, Phase Error, and EVM) are based on the Slot to Measure.

The slot scope is defined in the "Demodulation Settings" (see chapter 6.7.1, "Slot Scope", on page 95), and it is indicated by a filled green box in the "Frame Configuration" (see figure 5-6). The Slot to Measure is indicated by a filled blue box.

Frame configuration and slot scope in the channel bar

In the channel bar of the R&S FSW GSM application, as well as in the configuration "Overview", the current frame configuration and slot scope are visualized in a miniature graphic. Furthermore, the burst type and modulation of the Slot to Measure are indicated.

Fig. 5-5: Frame configuration in GSM application channel bar

The graphic can be interpreted as follows:

Shape/Color	Meaning
	Each slot is represented by a small box
	Active slots are indicated by polygonal symbols
	Slots within the defined slot scope are highlighted green
	The defined Slot to Measure is highlighted blue; the burst type and modulation defined for this slot are indicated to the right of the graphic

Frame configuration in the Frame and Slot Scope dialog boxes

The same graphic is displayed in the "Frame Configuration" of the "Frame" dialog box (see "Frame Configuration: Select Slot to Configure" on page 65) and in the "Slot Scope" tab of the "Demodulation" dialog box (see chapter 6.7.1, "Slot Scope", on page 95).

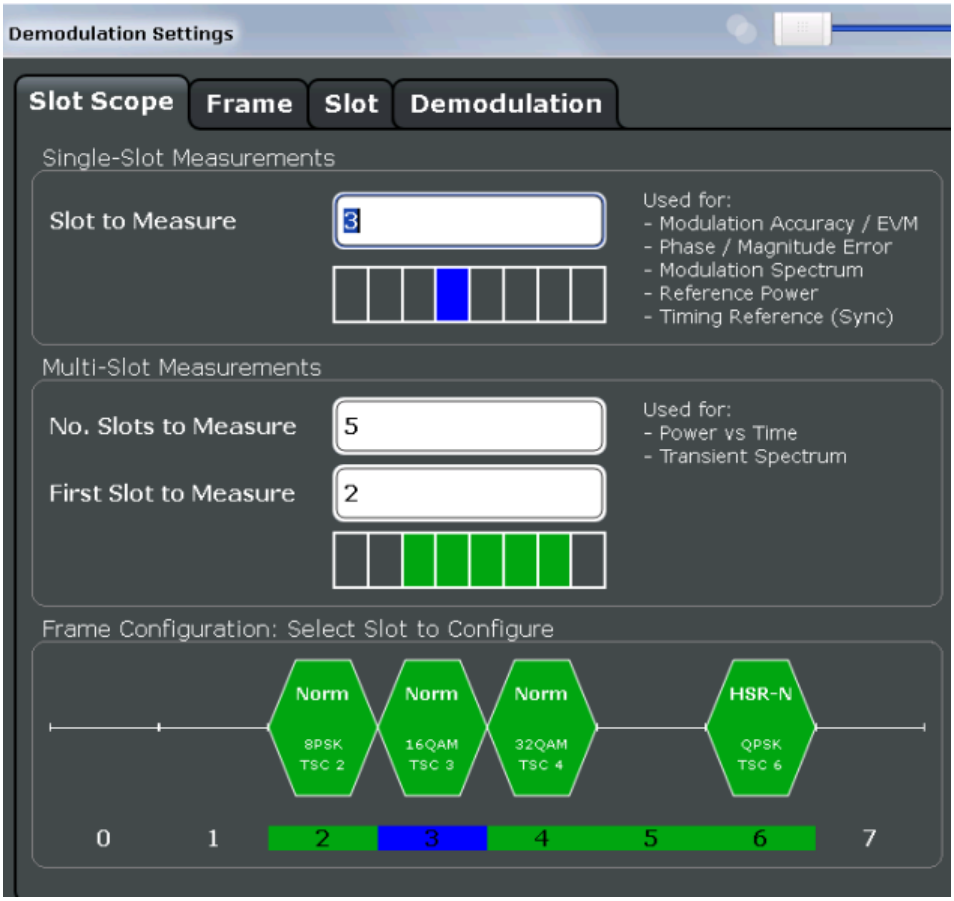


Fig. 5-6: Frame configuration in "Slot Scope" settings

This graphic can be interpreted as follows:

- Each slot is represented by its number (0 to 7).
- Slot numbers within the defined slot scope are highlighted green.
- The number of the defined Slot to Measure is highlighted blue.
- Active slots are indicated by polygonal symbols above the number which contain the following information:
  - The burst type, e.g. "Norm" for a normal burst
  - The modulation, e.g. GMSK
  - The training sequence TSC (and Set) or Sync (for access bursts)

5.7 Overview of filters in the R&S FSW GSM application

The R&S FSW GSM application requires a number of filters for different stages of signal processing. These include the "Multicarrier" filter (for multicarrier base station measurements only), the "Power vs Time" filter and the "Measurement" filter. A signal flow diagram is shown in figure 5-7 to illustrate where the different filters are used.

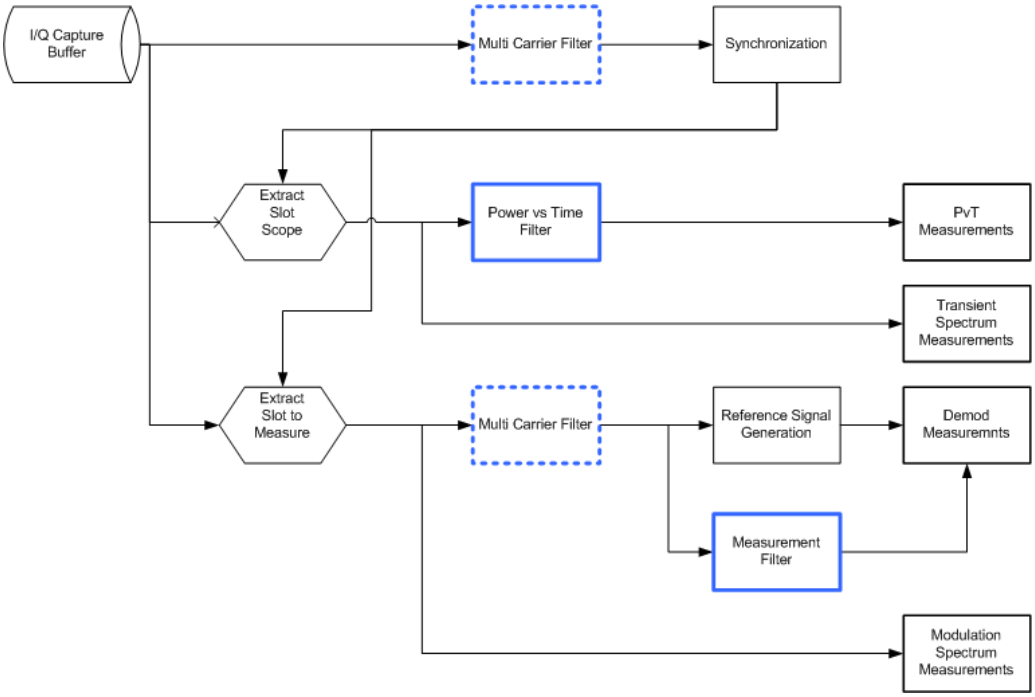


Fig. 5-7: Signal flow diagram highlighting filtering operations

5.7.1 Multicarrier Filter

The "Multicarrier" filter is only applied to the captured data if the "Multicarrier BTS" option is selected (see "Multicarrier BTS" on page 69). This filter is used to suppress neighboring channels which may disturb measurement of the channel of interest. The output from the "Multicarrier" filter is used to perform synchronization and demodulation. This filter is not applied for Power vs Time or Spectrum measurements. For suppression of neighboring channels in the Power vs Time measurement, see the Power vs Time Filter. The frequency response of the "Multicarrier" filter is shown in figure 5-8.

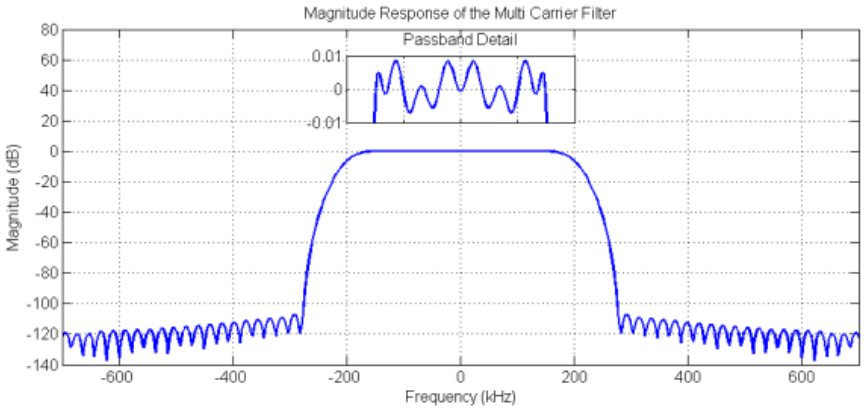


Fig. 5-8: Frequency Response of the Multicarrier Filter

5.7.2 Power vs Time Filter

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see "PvT Full Burst" on page 25).

The following filters are available:

Single-carrier filters:

- 1 MHz Gauss
- 500 kHz Gauss
- 600 kHz

Multicarrier filters:

- 400 kHz MC
- 300 kHz MC

The magnitude and step responses of the different "Power vs Time" filters are shown in figure 5-9 and figure 5-10, respectively. In general, the smaller the filter bandwidth, the worse the step response becomes (in terms of "ringing" effects) and the better the suppression of interference at higher frequencies. Gaussian type filters are especially useful for signals with "sharp" edges as the step response does not exhibit overshoot.

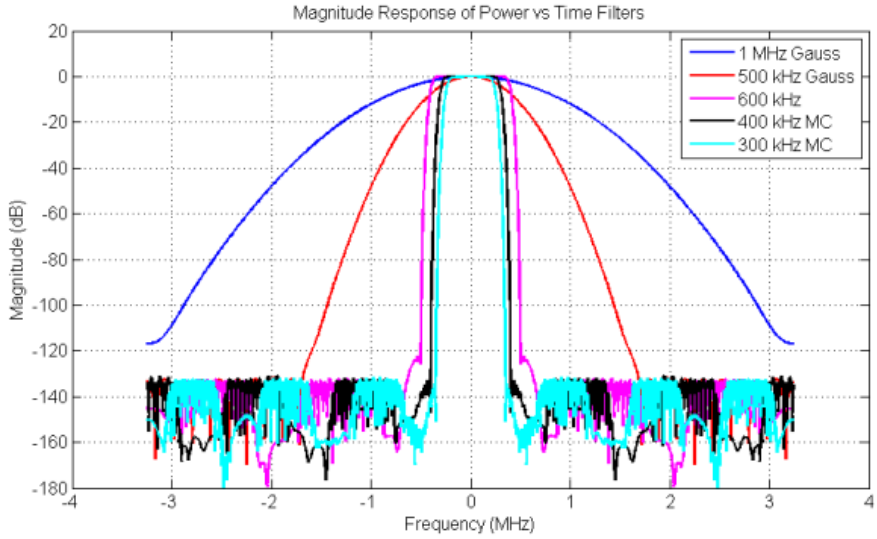


Fig. 5-9: Magnitude Response of the Power vs Time Filters

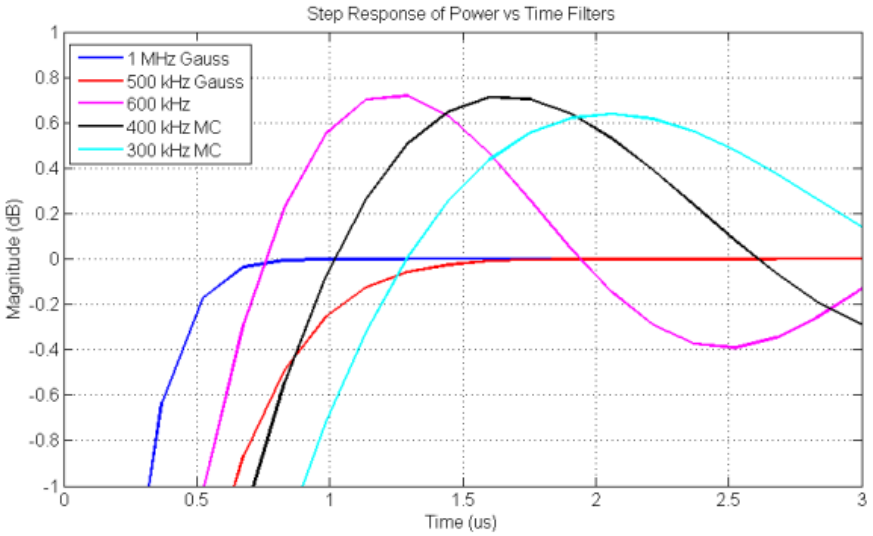


Fig. 5-10: Step Response of the Power vs Time Filters

5.7.3 Measurement Filter

The "Measurement" filter is used to limit the bandwidth of the demodulation measurements and is described in the 3GPP standard document *TS 45.005* for QPSK, 8PSK, 16QAM and 32QAM as follows:

- *a raised-cosine filter with roll-off 0.25 and single side-band 6 dB bandwidth 90 kHz for normal symbol rate and for higher symbol-rate using narrow bandwidth pulse-shaping filter*
- *a raised-cosine filter with roll-off 0.25 and single side-band 6 dB bandwidth 108 kHz for higher symbol-rate using wide bandwidth pulse-shaping filter*

In addition to these filters, a "Measurement" filter for GMSK is used in the R&S FSW GSM application to limit the effects of out-of-band interference due to the high sampling rate of 6.5 MHz which is used. The magnitude responses of all the "Measurement" filters are shown in figure 5-11.

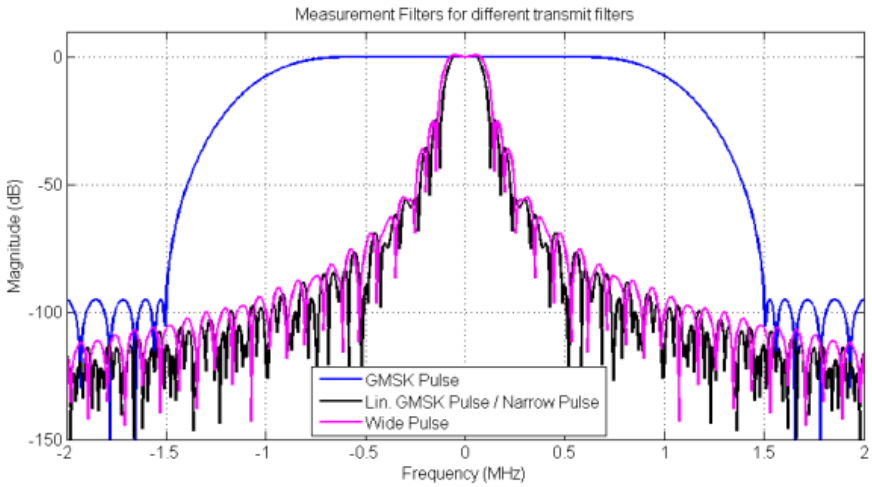


Fig. 5-11: Magnitude Responses of Measurement Filters for Demodulation Measurements

5.8 Dependency of Slot Parameters

The parameters that define a slot used for a GSM measurement are dependant on each other, and only the following combinations of these parameters are available in the R&S FSW GSM application (see chapter 6.3.2, "Slot Settings", on page 65).

Table 5-5: Dependency of slot parameters

Burst Type	Modulation	Filter	TSC
AB	GMSK	GMSK Pulse	TS 0, TS 1, TS 2
			User
HSR	QPSK, 16QAM, 32QAM	Narrow Pulse, Wide Pulse	TSC 0, …, TSC 7
			User
NB	8PSK, 16QAM, 32QAM	Linearised GMSK Pulse	TSC 0, …, TSC 7
			User
	AQPSK	Linearised GMSK Pulse	Subchannel 1: TSC 0 (Set 1), …, TSC 7 (Set 1) Subchannel 2: TSC 0 (Set 1), …, TSC 7 (Set 1), TSC 0 (Set 2), …, TSC 7 (Set 2)
			Subchannel 1: User Subchannel 2: User
	GMSK	GMSK Pulse	TSC 0 (Set 1), …, TSC 7 (Set 1), TSC 0 (Set 2), …, TSC 7 (Set 2)
			User

5.9 Definition of the Symbol Period

The following sections define the symbol period for various modulation types.

5.9.1 GMSK Modulation (Normal Symbol Rate)

The GMSK frequency pulse is defined in the standard document "3GPP TS 45.004" as a Gaussian pulse convolved with a rectangular pulse, as illustrated at the top of figure 5-12. The phase of a GMSK signal due to a sequence of symbols {α} is defined in the standard as:

$$\varphi(t') = \sum_i \alpha_i \pi h \int_{-\infty}^{t'-iT} g(u)du$$

Phase of a GMSK signal due to a sequence of symbols (5 - 1)

where:

- **g(t)**: the frequency pulse
- **T**: the normal symbol period

The modulating index is chosen such that the maximum phase change of π/2 radians per data interval is achieved.

Note that the standard specifies:

"The time reference t' = 0 is the start of the active part of the burst as shown in GMSK Frequency Pulse (top) and phase of the first tail symbol (bottom). This is also the start of the bit period of bit number 0 (the first tail bit) as defined in 3GPP TS 45.002."

The phase change due to the first tail symbol is illustrated at the bottom of GMSK Frequency Pulse (top) and phase of the first tail symbol (bottom), where you can see that the "decision instant" corresponding to the center of the frequency pulse occurs at the beginning of the first symbol period, i.e. at t' = 0.

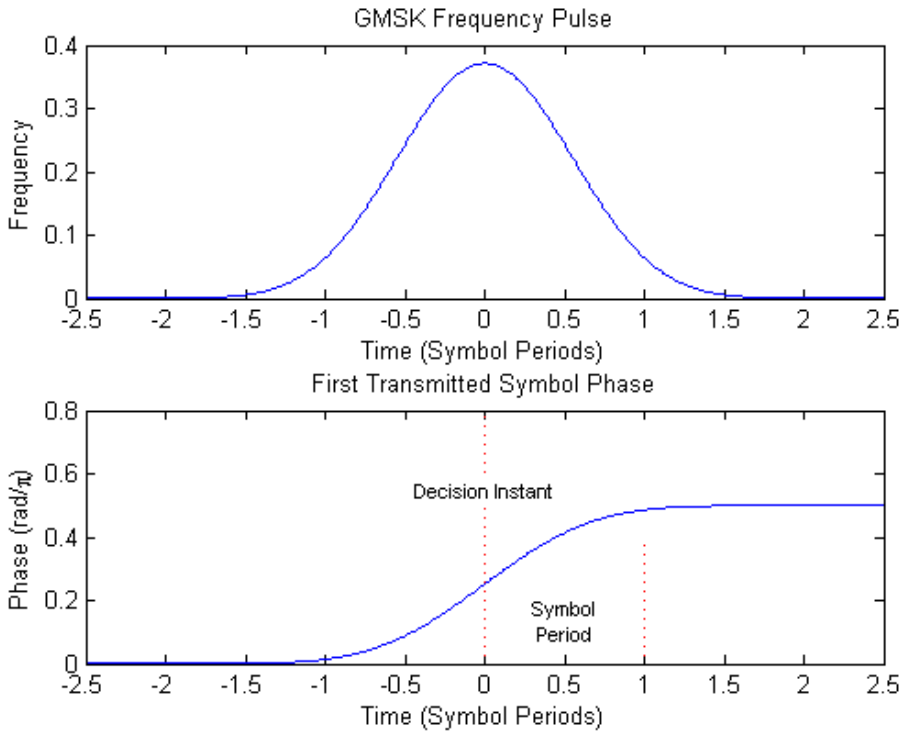


Fig. 5-12: GMSK Frequency Pulse (top) and phase of the first tail symbol (bottom)

5.9.2 8PSK, 16QAM and 32QAM Modulation (Normal Symbol Rate)

The EDGE transmit pulse is defined in the standard document "3GPP TS 45.004" as a linearised GMSK pulse, as illustrated at the top of figure 5-13. Note that according to the definition in the standard, the center of the pulse occurs at 2.5 T, where T is the normal symbol period (NSP). The baseband signal due to a sequence of symbols $\{\hat{s}_i\}$ is defined in the standard as:

$$y(t') = \sum_i \hat{s}_i \cdot c_0(t' - iT + 2T)$$

Baseband signal due to a sequence of symbols (5 - 2)

where:

$\mathbf{c_0(t)}$: the transmit pulse

Note that the standard specifies:

"The time reference t' = 0 is the start of the active part of the burst as shown in EDGE transmit pulse (top) and the first transmitted symbol (bottom). This is also the start of the symbol period of symbol number 0 (containing the first tail bit) as defined in 3GPP TS 45.002."

The transmitted pulse for the first tail symbol is illustrated in the lower part of EDGE transmit pulse (top) and the first transmitted symbol (bottom), where it can be seen that

the "decision instant" corresponding to the center of the transmit pulse occurs in the center of the first symbol period, i.e. at t'=0.5T.

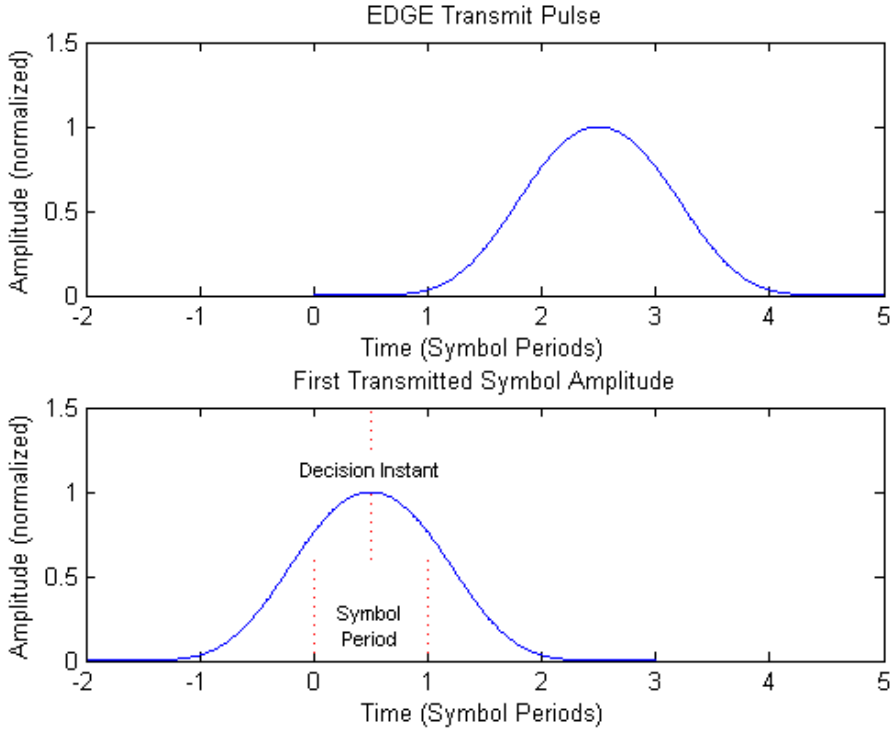


Fig. 5-13: EDGE transmit pulse (top) and the first transmitted symbol (bottom)

The description above also applies to the 16QAM and 32QAM modulations defined for EDGE Evolution, using the "normal" symbol rate.

5.9.3 QPSK, 16QAM and 32QAM Modulation (Higher Symbol Rate)

For the newer "reduced" symbol period (higher symbol rate) the standard document "3GPP TS 45.004" defines two transmit pulse shapes; the so-called "narrow" and "wide" pulses. The narrow pulse is the same linearised GMSK pulse as described in chapter 5.9.2, "8PSK, 16QAM and 32QAM Modulation (Normal Symbol Rate)", on page 48, while the wide pulse was designed based on a numerically optimized set of discrete filter coefficients. Both narrow and wide pulse shapes are illustrated at the top of figure 5-14, where you can see that the center of the pulse occurs at 3T, with T being the reduced symbol period. For a sequence of symbols $\{\hat{s}_i\}$, the transmitted signal is defined in the standard as:

$$y(t') = \sum_i \hat{s}_i \cdot c(t' - iT + 2.5T)$$

The transmitted signal for a sequence of symbols (5 - 3)

where:

c(t): the transmit pulse(which may be either the narrow or wide pulse)

Note that the standard specifies:

"The time reference t' = 0 is the start of the active part of the burst as shown in EDGE Evolution transmit pulses (top) and the first transmitted symbols (bottom). This is also the start of the symbol period of symbol number 0 (containing the first tail bit) as defined in 3GPP TS 45.002."

The transmitted pulse for the first tail symbol is illustrated at the bottom of EDGE Evolution transmit pulses (top) and the first transmitted symbols (bottom), where you can see that the "decision instant" corresponding to the center of the transmit pulse occurs in the center of the first symbol period, i.e. at t'=0.5T.

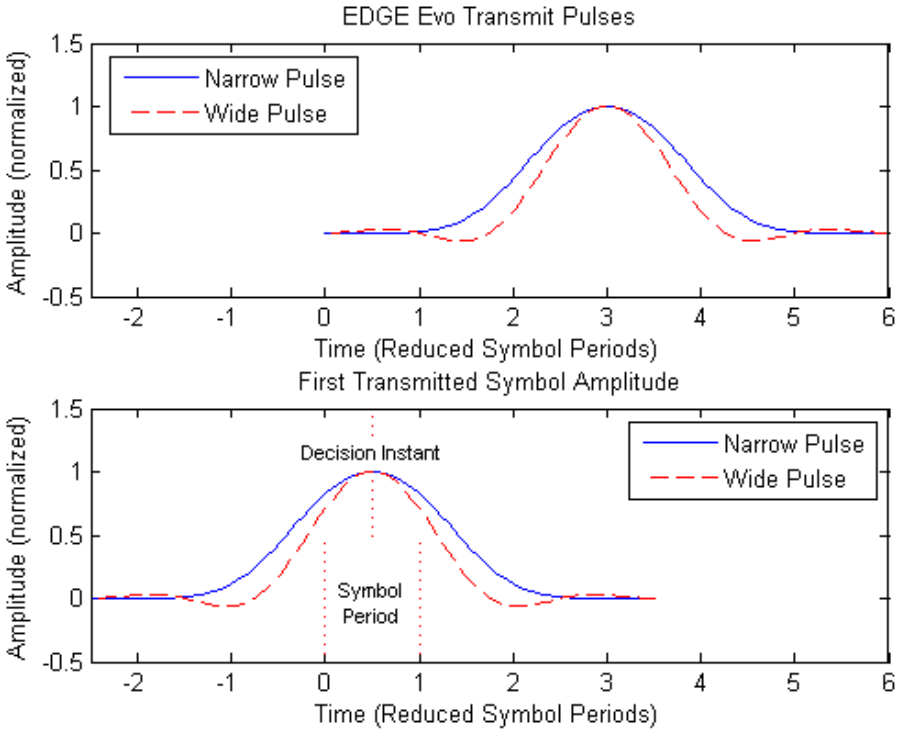


Fig. 5-14: EDGE Evolution transmit pulses (top) and the first transmitted symbols (bottom)

5.10 Timeslot Alignment

Reference Time

The definition of a "reference time" is necessary for the following description of timeslot alignment. In the standard document "3GPP TS 45.010", in Section 5.7 it is stated that:

"Irrespective of the symbol duration used, the center of the training sequence shall occur at the same point in time. "

This is illustrated in Figure 5.7.3 of the standard document "3GPP TS 45.010" which is reproduced below for convenience (figure 5-15). Due to this requirement, the "middle of TSC" or "center of Active Part" shall be used as the reference time when specifying time-slot alignment. Additionally, the "middle of TSC" is used for the alignment of the Power vs Time limit masks (see also "Limit Line Time Alignment" on page 102).

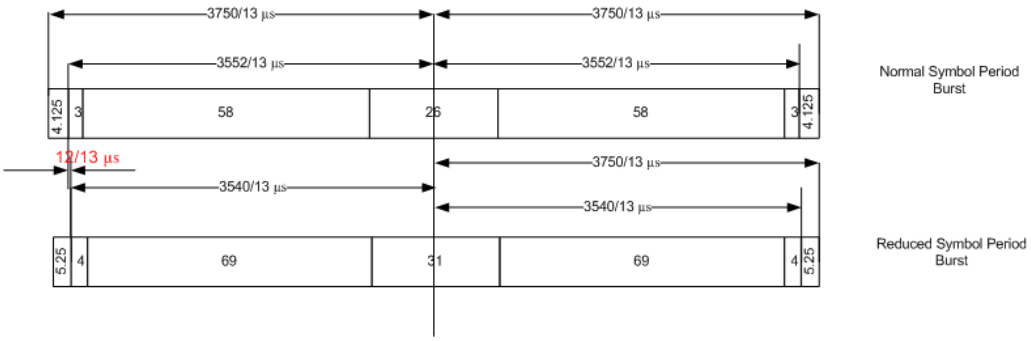


Fig. 5-15: Timing alignment between normal symbol period and reduced symbol period bursts

As described in chapter 5.9, "Definition of the Symbol Period", on page 47, the middle of TSC can be defined with respect to symbol periods and symbol decision instants. This is illustrated in figure 5-16. You can see that for normal symbol period bursts (Normal bursts), the middle of TSC for GMSK occurs exactly at the decision instant of symbol 74. However, for EDGE it occurs between the decision instants of symbols 73 and 74, while for reduced symbol period bursts (Higher Symbol Rate bursts), it occurs exactly at the decision instant of symbol 88.

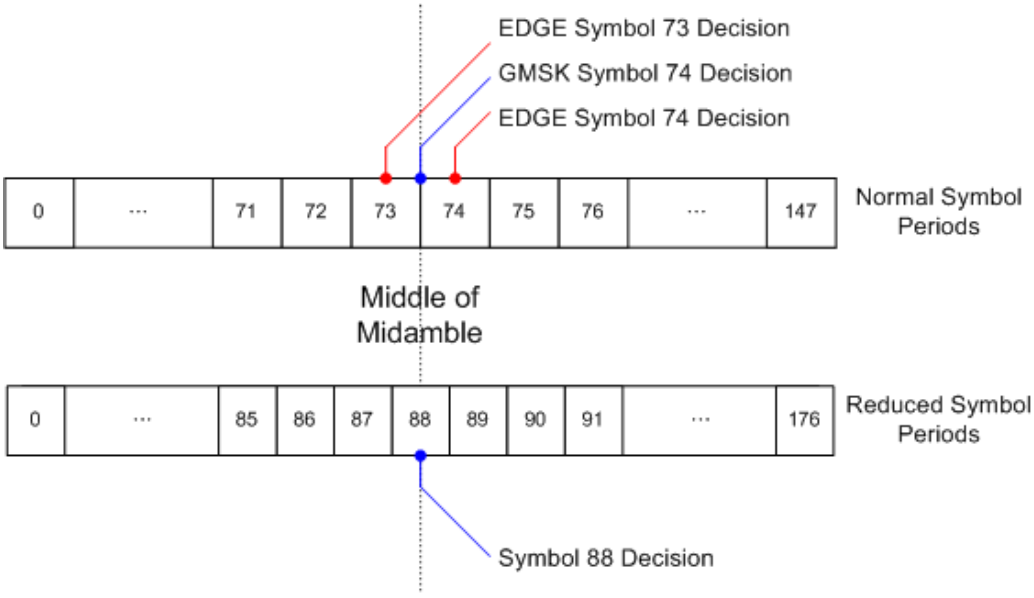


Fig. 5-16: Middle of TSC for normal and reduced symbol period bursts.

Timeslot alignment within the frame

The standard document "3GPP TS 45.010" provides details on the alignment of slots within the GSM frame:

"Optionally, the BTS may use a timeslot length of 157 normal symbol periods on timeslots with TN = 0 and 4, and 156 normal symbol periods on timeslots with TN = 1, 2, 3, 5, 6, 7, rather than 156.25 normal symbol periods on all timeslots"

The alignment of slots therefore falls under the "Not Equal Timeslot Length" (Equal Timeslot Length = off) or the "Equal Timeslot Length" (Equal Timeslot Length = on) criterion (see also "Equal Timeslot Length" on page 64), which are illustrated in figure 5-17.

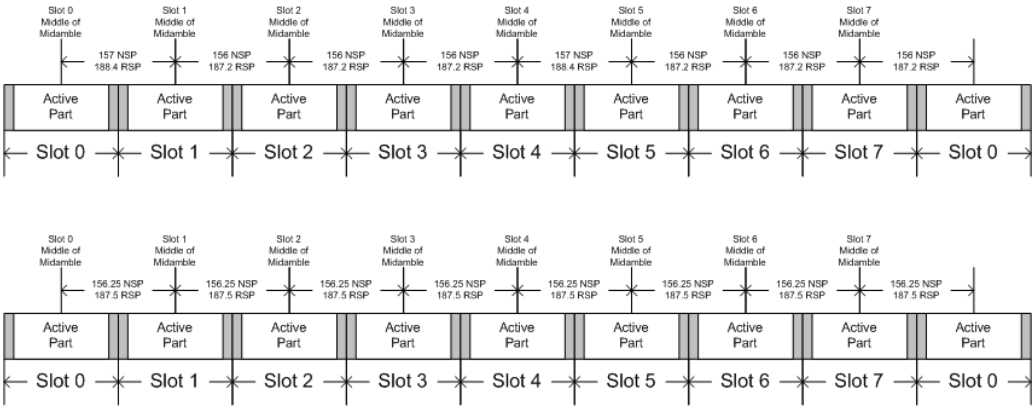


Fig. 5-17: "Not equal"(top) and "equal" (bottom) timeslot length criteria

Note that, since the reference point at the "middle of TSC" of each slot must coincide, the length of the guard interval between successive bursts will depend on both the timeslot length and the symbol rate of bursts in successive slots. As stated in the standard "3GPP TS 45.010", for the "Equal Timeslot Length" case:

"… if there is a pair of different symbol period bursts on adjacent timeslots, then the guard period between the two bursts shall be 8.5 normal symbol periods which equals 10.2 reduced symbol periods."

For the "Not Equal Timeslot Length" case, deriving the guard period length is somewhat more complicated, and the possible values are summarized in Table 5.7.2 of "3GPP TS 45.010", reproduced below as Guard period lengths between different timeslots, for convenience:

Table 5-6: Guard period lengths between different timeslots

Burst Transition	Guard Period Between Timeslots (In terms of normal symbol periods)		Guard Period Between Timeslots (In terms of reduced symbol periods)	
	TS0 and TS1 or TS4 and TS5	Any other timeslot pair	TS0 and TS1 or TS4 and TS5	Any other timeslot pair
normal symbol period to normal symbol period	9	8	10.8	9.6
normal symbol period to reduced symbol period	9.25	8.25	11.1	9.9

Burst Transition	Guard Period Between Timeslots (In terms of normal symbol periods)		Guard Period Between Timeslots (In terms of reduced symbol periods)	
	TS0 and TS1 or TS4 and TS5	Any other timeslot pair	TS0 and TS1 or TS4 and TS5	Any other timeslot pair
reduced symbol period to normal symbol period	9.25	8.25	11.1	9.9
reduced symbol period to reduced symbol period	9.5	8.5	11.4	10.2

5.11 Delta to Sync Values

The "Delta to Sync" value is defined as the distance between the mid of the TSC and the TSC of the Slot to Measure.

The results are provided in the unit NSP, which stands for Normal Symbol Period, i.e. the duration of one symbol using a normal symbol rate (approx. 3.69µs). The measured "Delta to Sync" values have a resolution of 0.02 NSP.

These values are either assumed to be constant (according to the 3GPP standard) or measured, depending on the setting of the Limit Line Time Alignment parameter ("Slot to measure" or "Per Slot").

According to the standard (see "Timeslot length" in 3GPP TS 45.010), there are either eight slots of equal length (156.25 NSP), or slot 0 and slot 4 have a length of 157 NSP while all other slots have a length of 156 NSP. For details see chapter 5.10, "Timeslot Alignment", on page 50.

The timeslot length is defined as the distance between the centers of the TSCs in successive slots. By setting the "Limit Time Alignment" parameter to "Per Slot", the "Delta to Sync" values can be measured and used in order to verify the timeslot lenghts.

Setting the Limit Line Time Alignment to "Slot to measure" displays the expected values (according to the standard and depending on the value of Equal Timeslot Length). These values are summarized in Expected "Delta to Sync" values in normal symbol periods (Slot to measure = 0, No. of slots = 8 and First slot to measure = 0).

Table 5-7: Expected "Delta to Sync" values in normal symbol periods

Slot Number	0 = Slot to measure	1	2	3	4	5	6	7
Equal Timeslot Length = On	0	156.25	312.50	468.75	625.00	781.25	937.50	1093.75
Equal Timeslot Length = Off	0	157	313	469	625	782	938	1094

5.12 Limit Check for Modulation Spectrum

The determined "Modulation Spectrum" values in the average (Avg) trace can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Modulation Spectrum" diagram (see "Modulation Spectrum Graph" on page 20).

The GSM standards define both absolute and relative limits for the spectrum. The limit check is considered to fail if *either* limit is exceeded.

The limits depend on the following parameters:

- Frequency band
- Device Type (only BTS type, not MS type)
- Burst Type / Modulation / Filter - limits are different for Higher Symbol Rate and Wide Pulse Filter (case 2) and others (case 1), see 3GPP TS 45.005, chapter 4.2.1.3
- The measured reference power (30 kHz bandwidth)
- The measured burst power level
- Number of active carriers for multicarrier BTS (see "No. of active Carriers" on page 70). The limit is relaxed by 10*log10(N) dB for offset frequencies ≥1.8 MHz, see 3GPP TS 45.005 chapter 4.2.1.2

5.13 Limit Check for Transient Spectrum

The determined "Transient Spectrum Accuracy" values can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Transient Spectrum" diagram (see "Transient Spectrum Graph" on page 27).

The limits depend on the following parameters:

- Graph: Limit check of maximum (Max) trace
- Table: Limit check of absolute and relative scalar values

- The limit masks are generated adaptively from the measured signal.
- The limits depend on the following parameters:
  – Frequency band (not for MS)
  – Burst Type / Modulation / Filter (not for MS)
  – The measured reference (slot) power

5.14 Limit Check for Power vs Time Results

The determined "Power vs Time" values can be checked against limits defined by the standard; the limit lines and the result of the limit check are indicated in the "Power vs Time" diagram (see "PvT Full Burst" on page 25) and in the "Power vs Slot" table (see "Power vs Slot" on page 24).

The limits depend on the following parameters:

- The maximum (Max) trace is checked agains the upper limit.
- The minimum (Min) trace is checked against the lower limit.
- The limit masks are generated adaptively from the measured signal according to the following parameters:
  – Frequency band (special masks for PCS1900 and DCS1800 BTS with GMSK)
  – Burst type
  – Modulation
  – Filter
  – The reference burst power is measured and the "0 dB line" of the limit mask is assigned to it.
  – For MS, the "-6 dB line" of the limit mask depends on the PCL. The PCL is derived from the measured burst power.

5.15 Impact of the "Statistic Count"

Generally, the "Statistic Count" defines how many measurements (or: analysis steps) are performed - equivalent to the "Sweep Count" in applications that perform sweeps.

In particular, the "Statistic Count" defines the number of frames to be included in statistical evaluations. For measurements on the Slot to Measure, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count", for statistical evaluations.

For Trigger to Sync measurements, where only one result is calculated per data acquisition, the "Statistic Count" determines how many values are considered for averaging.

Statistic count for Trigger to Sync vs other measurements

As mentioned above, the "Statistic Count" for Trigger to Sync measurements refers to the number of data acquisitions, whereas for all other measurements, the value refers to the number of frames. Since usually more than one frame is captured per data acquisition, the number of data acquisitions required to obtain the required number of results (the "Statistic Count") may vary considerably. If both Trigger to Sync and other result types are active at the same time, the latter are finished first and the traces (in particular the current measurement trace) remains unchanged until the Trigger to Sync measurement has also finished. The counter in the channel bar counts the "slower" of the two events, i.e. the number of measurements if a Trigger to Sync result display is active.

In **MSRA mode**, only a single data acquisition is performed (by the MSRA Master) and the R&S FSW GSM application analyzes this data repeatedly. Thus, the Trigger to Sync measurement will only count one data acquisition and can never reach a larger "Statistic Count" value.

Tip: You can query the current value of the counter for both Trigger to Sync and other measurements in remote control, as well. See chapter 11.4.5.2, "Configuring and Performing Sweeps", on page 182.

Obviously, the "Statistic Count" has an impact on all results and values that are re-calculated after each measurement. The higher the count, the more values are taken into consideration, and the more likely the result of the calculation will converge to a stable value. On the other hand, the fewer measurements are considered, the higher the variance of the individual results, and the less reliable the calculation result will be.

For instance, if the "Statistic Count" is set to values smaller than 5, the measured reference power for Modulation Spectrum Table (see "Modulation Spectrum Table" on page 22) and Transient Spectrum Table (see "Transient Spectrum Table" on page 28) measurements increases. This leads to a higher variance of the measured relative powers at the offset frequencies, and thus to a reduced measurement dynamic.

For the Power vs Time (see "PvT Full Burst" on page 25) and Power vs Slot (see "Power vs Slot" on page 24) measurements, a small "Statistic Count" increases the variance of the measured slot powers. The slot power is required to calculate the PVT limit lines.

5.16 GSM in MSRA Operating Mode

The GSM application can also be used to analyze data in MSRA operating mode. In MSRA operating mode, only the MSRA Master actually captures data; the MSRA applications receive an extract of the captured data for analysis, referred to as the **analysis interval**. For the R&S FSW GSM application in MSRA operating mode, the analysis interval corresponds to the GSM capture buffer, and is defined by the same settings used to define the data acquisition in Signal and Spectrum Analyzer mode (see chapter 6.6, "Data Acquisition", on page 90). In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval for the R&S FSW GSM measurement.

Data coverage for each active application

Generally, if a signal contains multiple data channels for multiple standards, separate applications are used to analyze each data channel. Thus, it is of interest to know which application is analyzing which data channel. The MSRA Master display indicates the data covered by each application, restricted to the channel bandwidth used by the corresponding standard (for GSM: 200 kHz), by vertical blue lines labeled with the application name.

Analysis line

A frequent question when analyzing multi-standard radio signals is how each data channel is correlated (in time) to others. Thus, an analysis line has been introduced in firmware version 1.60. The analysis line is a common time marker for all MSRA applications. It can be positioned in any MSRA application or the MSRA Master and is then adjusted in all other applications. Thus, you can easily analyze the results at a specific time in the measurement in all applications and determine correlations.

If the marked point in time is contained in the analysis interval of the application, the line is indicated in all time-based result displays, such as time, symbol, slot or bit diagrams. By default, the analysis line is displayed, however, it can be hidden from view manually. In all result displays, the "AL" label in the window title bar indicates whether or not the analysis line lies within the analysis interval or not:

- **orange "AL"**: the line lies within the interval
- **white "AL"**: the line lies within the interval, but is not displayed (hidden)
- **no "AL"**: the line lies outside the interval

Trigger source for MSRA Master

Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application (see chapter 5.5, "Trigger settings", on page 39).

In the default state in MSRA operating mode, the Sequencer is active in continuous mode. Thus, the MSRA Master performs a data acquisition and then the active applications

evaluate the data in turn, after which the MSRA Master performs a data acquisition and so on. As opposed to some other R&S FSW applications in MSRA mode, statistical evaluation of the traces (averaging, MinHold, MaxHold) is not reset after each evaluation in the R&S FSW GSM application.

You can take advantage of this feature in the R&S FSW GSM application by performing continuous data acquisition in MSRA operating mode over a longer period (e.g. over night), and then checking the average or MinHold/MaxHold trace to detect any irregularities in the captured data.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

6 Configuration

GSM measurements require a special application on the R&S FSW, which you activate using the MODE key on the front panel.

When you switch a measurement channel to the GSM application the first time, a set of parameters is passed on from the currently active application (see chapter 6.1, "Default Settings for GSM measurements", on page 59). After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

When you activate a measurement channel in the GSM application, a GSM measurement for the input signal is started automatically with the default configuration. The "GSM" menu is displayed and provides access to the most important configuration functions.

The MARKER FUNCT and LINES menus are currently not used.

Importing and Exporting I/Q Data

The I/Q data to be evaluated in the GSM application can not only be captured by the GSM application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the GSM application can be exported for further analysis in external applications.

The import and export functions are available in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar.

For details on importing and exporting I/Q data see the R&S FSW I/Q Analyzer User Manual.

- Default Settings for GSM measurements....59
- Configuration Overview....61
- Signal Description....63
- Input and Frontend Settings....70
- Trigger Settings....85
- Data Acquisition....90
- Demodulation....94
- Measurement Settings....100
- Adjusting Settings Automatically....107

6.1 Default Settings for GSM measurements

When you switch a measurement channel to the GSM application the first time, a set of parameters is passed on from the currently active application:

- center frequency and frequency offset
- reference level and reference level offset

- attenuation
- preamplification
- signal source
- input coupling

After initial setup, the parameters for the measurement channel are stored upon exiting and restored upon re-entering the channel. Thus, you can switch between applications quickly and easily.

Apart from these settings, the following default settings are activated directly after a measurement channel has been set to the GSM application, or after a Preset Channel:

Table 6-1: Default settings for GSM channels

Parameter	Value
Sweep mode	CONTINUOUS
Trigger settings	FREE RUN
Device type	BTS Normal
Mutli-Carrier BTS	Off
Power class	1
Frequency band	E-GSM 900
Modulation	NB GMSK
YIG-Preselector	Off
Capture time	100.0 ms
Swap I/Q	Off
Statistic count	200
Slot to Measure	0
No. slots to measure	1
First slot to measure	0
Synchronization	Burst + TSC
TSC	TSC 0 (Set 1)
Measure only on sync	Off
Evaluations	Window 1: Magnitude Capture Window 2: PvT Full Burst Window 3: Modulation Accuracy Window 4: Power vs Slot

Table 6-2: Default traces depending on result display

Result display	Trace 1	Trace 2	Trace 3	Trace 4
Magnitude Capture	Clear Write	-	-	-
Power vs Time EVM vs Time Phase Error vs Time Magnitude Error vs Time	Average	Max Hold	Min Hold	Clear Write
Constellation: Graph	-	-	-	Clear Write Blank
Modulation Spectrum Graph	Average	Clear Write	-	-
Transient Spectrum Graph	Max Hold	Clear Write	-	-
Trigger to Sync: Graph	Histogram Blank	PDF of Average Blank	-	-

6.2 Configuration Overview

Throughout the measurement channel configuration, an overview of the most important currently defined settings is provided in the "Overview". The "Overview" is displayed when you select the "Overview" icon, which is available at the bottom of all softkey menus.

In addition to the main measurement settings, the "Overview" provides quick access to the main settings dialog boxes. The individual configuration steps are displayed in the order of the data flow. Thus, you can easily configure an entire measurement channel from input over processing to output and analysis by stepping through the dialog boxes as indicated in the "Overview".

In particular, the "Overview" provides quick access to the following configuration dialog boxes (listed in the recommended order of processing):

1. Signal Description
   See chapter 6.3, "Signal Description", on page 63
2. Input and Frontend Settings
   See chapter 6.4, "Input and Frontend Settings", on page 70
3. Triggering
   See chapter 6.5, "Trigger Settings", on page 85
4. Data Acquisition
   See chapter 6.6, "Data Acquisition", on page 90
5. Demodulation Settings
   See chapter 6.7, "Demodulation", on page 94
6. Measurement Settings
   See chapter 6.8, "Measurement Settings", on page 100
7. Result Configuration
   See chapter 7.1, "Result Configuration", on page 109
8. Display Configuration
   See chapter 7.2, "Display Configuration", on page 115

To configure settings

► Select any button to open the corresponding dialog box. The corresponding dialog box is opened with the focus on the selected setting.

Preset Channel
Select the "Preset Channel" button in the lower lefthand corner of the "Overview" to restore all measurement settings **in the current channel** to their default values.

Note that the PRESET key on the front panel restores all measurements **in all measurement channels** on the R&S FSW to their default values!

For details see chapter 6.1, "Default Settings for GSM measurements", on page 59.

Remote command:
`SYSTem:PRESet:CHANnel[:EXECute]` on page 141

Specifics for
The measurement channel may contain several windows for different results. Thus, the settings indicated in the "Overview" and configured in the dialog boxes vary depending on the selected window.

Select an active window from the "Specifics for" selection list that is displayed in the "Overview" and in all window-specific configuration dialog boxes.

The "Overview" and dialog boxes are updated to indicate the settings for the selected window.

6.3 Signal Description

The signal description provides information on the expected input signal, which optimizes frame detection and measurement.

The "Signal Description" settings are available from the configuration "Overview".

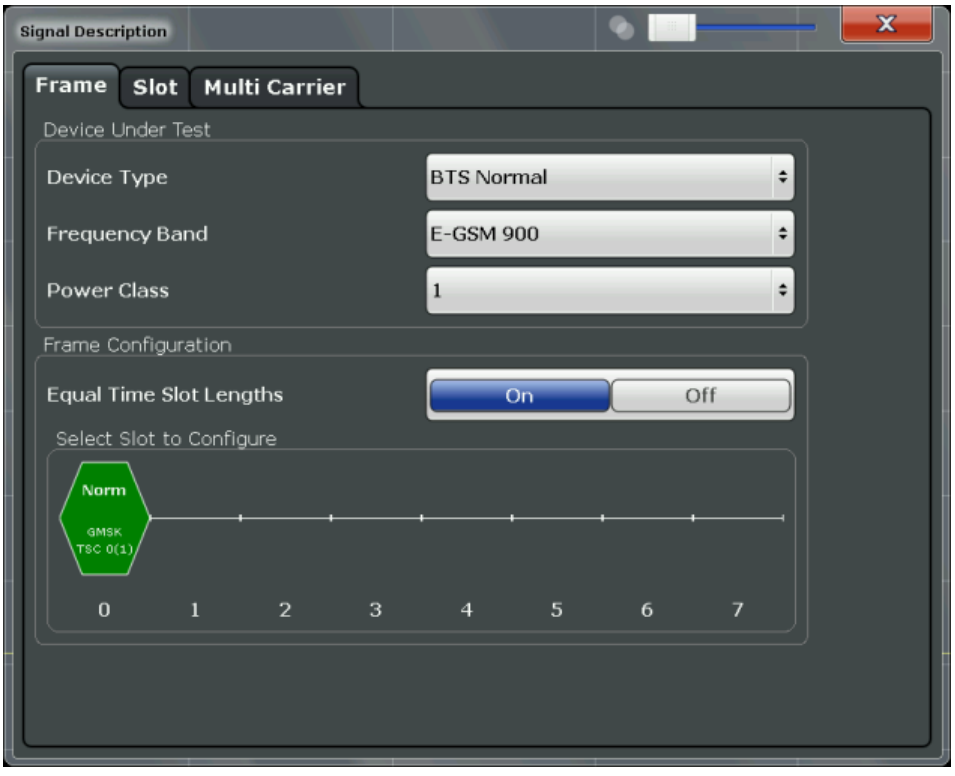
- Frame and DUT Settings.....63
- Slot Settings.....65
- Multicarrier Settings.....69

6.3.1 Frame and DUT Settings

Frame settings determine the frame configuration used by the device under test.

The "Frame" settings are available when you do one of the following:

- In the "Overview", select the "Signal Description" or "Demodulation" button, then switch to the "Frames" tab.



Device Type
Defines the type of device under test (DUT). The following types are available:

- BTS Normal
- BTS Micro
- BTS Pico
- MS Normal
- MS Small

The default device type is "BTS Normal".

Remote command:
CONFigure[:MS]:DEVice:TYPE on page 142

Frequency Band
The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 33.

The following frequency bands are supported:

- T-GSM 380
- T-GSM 410
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- T-GSM 810
- GSM 850
- P-GSM 900
- E-GSM 900
- R-GSM 900
- T-GSM 900
- DCS 1800
- PCS 1900

The default frequency band is "E-GSM 900".

Remote command:
CONFigure[:MS]:NETWork[:TYPE] on page 144
CONFigure[:MS]:NETWork:FREQuency:BAND on page 143

Power Class
The following power classes are supported:

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:
CONFigure[:MS]:POWer:CLASs on page 145

Equal Timeslot Length
This parameter is only taken into account if "Limit Time Alignment" is set to "Slot to measure" (see "Limit Line Time Alignment" on page 102).

If activated, all slots of a frame are considered to have the same length (8 x 156.26 normal symbol periods).

In this case, the limit line for each slot (required for the "Power vs Time" spectrum masks) is aligned by measuring the TSC of the Slot to Measure only, and using this value to align the limit line for all slots in the frame (see also "PvT Full Burst" on page 25).

If deactivated, slots number 0 and 4 of a frame have a longer duration, all others have a shorter duration compared to the "Equal Timeslot Length" (157, 156, 156, 156, 157, 156, 156, 156 normal symbol periods).

See GPP TS 51.021 and 3GPP TS 45.010 chapter "6.7 Timeslot length" for further details.

Remote command:
`CONFigure[:MS]:CHANnel:FRAMe:EQUal` on page 146

Frame Configuration: Select Slot to Configure
This area shows a graphical representation of the configuration of each slot. Select a slot to display its "Slot" dialog box (see chapter 6.3.2, "Slot Settings", on page 65).

For active slots the following information is shown:

- The burst type, e.g. "Normal (NB)" for a normal burst.
- The modulation, e.g. GMSK.
- The training sequence TSC (and Set)

For details on how to interpret the graphic, see "Frame configuration and slot scope in the channel bar" on page 41.

6.3.2 Slot Settings

The "Slot" settings are available when you do one of the following:

- In the "Overview", select the "Signal Description" or "Demodulation" button, then switch to the "Slot" tab.
- Press the MEAS CONFIG key, then the "Slot to Measure" softkey.

The individual slots are configured on separate tabs. The dialog box for the selected slot is displayed directly when you select a slot in the "Frame Configuration" graphic on the "Frame" tab (see "Frame Configuration: Select Slot to Configure" on page 65).

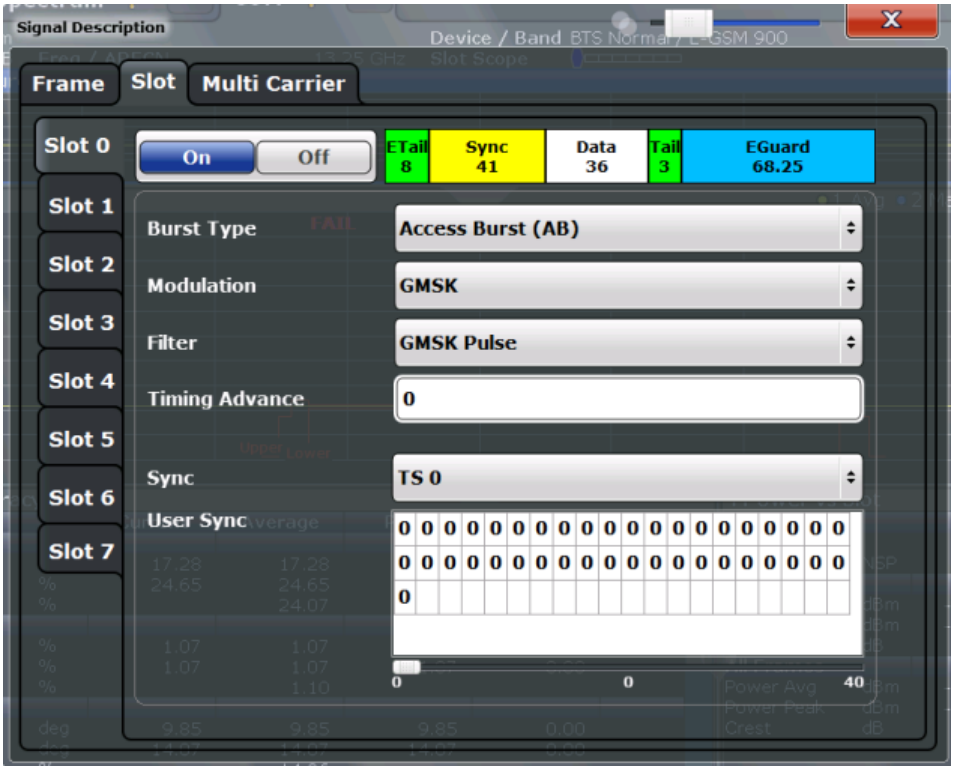
To configure a different slot, select the corresponding vertical tab in the "Slot" tab.

Slot structure display
The basic slot structure according to the selected Frequency Band and Power Class is displayed graphically for reference.

White fields indicate unknown data; colored fields indicate known symbol sequences.

The slot settings vary slightly for different burst types.

Fig. 6-1: Slot configuration for normal and higher symbol rate bursts


Signal Description
Device / Band BTS Normal / E-GSM 900
Frame
Slot
Multi Carrier
Slot 0
Slot 1
Slot 2
Slot 3
Slot 4
Slot 5
Slot 6
Slot 7
On
Off
ETail 8
Sync 41
Data 36
Tail 3
EGuard 68.25
Burst Type
Access Burst (AB)
Modulation
GMSK
Filter
GMSK Pulse
Timing Advance
0
Sync
TS 0
User Sync
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

The "Slot" settings are dependant on each other, and only specific combinations of these parameters are available in this dialog box (see chapter 5.8, "Dependency of Slot Parameters", on page 46).

Slot State (On/Off)
Activates or deactivates the selected slot. The R&S FSW GSM application expects an input signal within the active slots only.

At least the Slot to Measure must be active in order to evaluate it.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>[:STATe]` on page 148

Burst Type
Assigns a burst type to the selected slot.

The following burst types are supported:
- Normal (NB)
- Higher Symbol Rate (HB)
- Access (AB)

The graphical slot structure is adapted according to the selected burst type.

Note: The "Slot" settings are dependant on each other, and only specific combinations of these parameters are available in this dialog box (see chapter 5.8, "Dependency of Slot Parameters", on page 46).

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE` on page 153

Modulation
Defines the modulation used in the slot.

The possible modulations depend on the set burst type (see chapter 5.8, "Dependency of Slot Parameters", on page 46).

The graphical slot structure is adapted according to the selected modulation.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:MTYPe` on page 148

SCPIR
This parameter is only available for **AQPSK** modulation.

It specifies the Subchannel Power Imbalance Ratio (SCPIR). The value of SCPIR affects the shape of the AQPSK constellation (see chapter 5.4, "AQPSK Modulation", on page 38). For an SCPIR of 0 dB the constellation is square (as in "normal" QPSK), while for other values of SCPIR the constellation becomes rectangular.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:SCPir` on page 149

Filter
Specifies the pulse shape of the modulator on the DUT and thus the measurement filter in the R&S FSW GSM application.

(For details see chapter 5.7.3, "Measurement Filter", on page 45).

The following filter types are supported for normal and higher symbol rate bursts:

- GMSK Pulse
- Linearised GMSK Pulse
- Narrow Pulse
- Wide Pulse

For access bursts, only a GMSK Pulse filter is supported.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:FILTer` on page 147

Timing Advance (Access Burst only)
Specifies the position of an access burst within a single slot as an offset in symbols from the slot start.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<Number>:TADVance` on page 151

Training Sequence TSC / Sync
(Note: for Access bursts, this setting is labelled "Sync", but the functionality is the same.)

The Training Sequence TSC or Sync values are known symbol sequences used to synchronize the measured signal with the expected input signal in a single slot.

The available values depend on the modulation as indicated in the table below.

For user-defined TSCs, select "User" and define the training sequence in the User TSC / User Sync table.

For more information on TSCs see "Training sequences (TSCs)" on page 37.

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:TSC` on page 151
AQPSK:
`CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC` on page 150

User TSC / User Sync
(Note: for Access bursts, this setting is labelled "User Sync", but the functionality is the same.)

Defines the bits of the user-defined TSC or Sync. The number of bits depend on the burst type and the modulation and is indicated in table 6-3.

For AQPSK modulation, the training sequence is defined for each subchannel, see chapter 5.4, "AQPSK Modulation", on page 38.

Note:
As the "User TSC" table in the dialog box only displays 25 bits at a time, a scrollbar beneath the table allows you to display the remaining bits. The currently selected bit number is indicated in the center of the scrollbar.

Table 6-3: Number of TSC bits depending on burst type and modulation

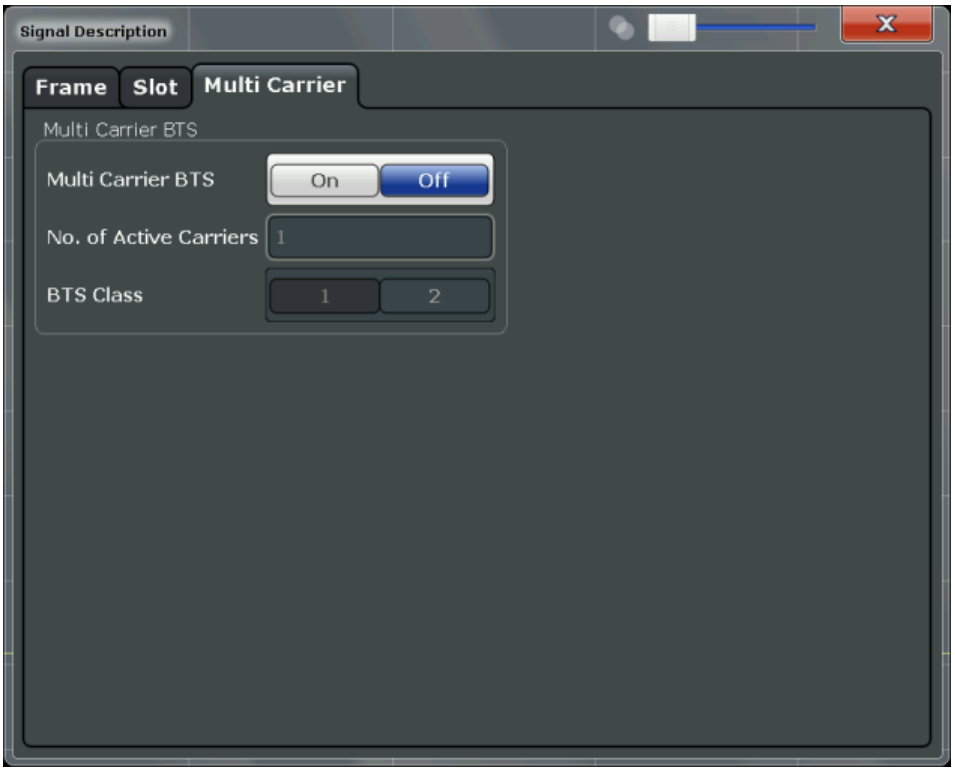
Burst Type	Modulation	Number of Bits
Normal	GMSK	26
Normal	8PSK	78
Normal	16QAM	104

Burst Type	Modulation	Number of Bits
Normal	32QAM	130
Higher Symbol Rate	QPSK	62
Higher Symbol Rate	16QAM	124
Higher Symbol Rate	32QAM	155
Access	GMSK	41

Remote command:
`CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER` on page 152
AQPSK:
`CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER` on page 150

6.3.3 Multicarrier Settings

The "Multicarrier" settings are only required for signals from base stations capable of using multiple carriers. They are available from the "Signal Description" dialog box which is displayed when you select the corresponding button in the configuration "Overview".



Multicarrier BTS
This parameter informs the R&S FSW GSM application that the measured signal is a multicarrier signal. This function is only available if the "Device Type" is a "BTS" type (see "Device Type" on page 63).

Activating this checkbox has the following effects:

- An additional multicarrier filter is switched into the demodulation path of the R&S FSW GSM application. This filter can, for example, suppress up to six adjacent channels with a channel spacing of 600 kHz from the measured channel (at the set center frequency) and 30 dB higher power compared to the measured channel. This filter is also taken into account during the generation of the ideal (reference) signal in order to get meaningful EVM values. (Otherwise there would be an increase in EVM because the measured signal has a smaller bandwidth compared to the reference signal).
- Additional multicarrier parameters become available.

Remote command:
`CONFigure[:MS]:MCARrier:MCBTs` on page 154

No. of active Carriers
Specifies the total number of active carriers of the multicarrier BTS to be measured. Its value affects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise"). The limit is relaxed by 10*log(N) dB for frequencies ≥ 1.8 MHz.

Remote command:
`CONFigure[:MS]:MCARrier:ACTCarriers` on page 154

BTS Class
Defines the base station class. The specified BTS Class effects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise" and chapter 4.3.2 "Base Transceiver Station", search for "Multicarrier BTS").

Remote command:
`CONFigure[:MS]:MCARrier:BTSClass` on page 154

6.4 Input and Frontend Settings

The R&S FSW can evaluate signals from different input sources and provide various types of output (such as noise or trigger signals).

The frequency and amplitude settings represent the "frontend" of the measurement setup.

- Input Source Settings....70
- Frequency Settings....77
- Amplitude Settings....79
- Output Settings....83

6.4.1 Input Source Settings

The input source determines which data the R&S FSW will analyze.

Input settings can be configured via the INPUT/OUTPUT key, in the "Input" dialog box.

Some settings are also available in the "Amplitude" tab of the "Amplitude" dialog box.

- Radio Frequency Input....71
- Digital I/Q Input Settings....72
- Analog Baseband Input Settings....75
- Probe Settings....76

6.4.1.1 Radio Frequency Input

The default input source for the R&S FSW is "Radio Frequency", i.e. the signal at the RF INPUT connector on the front panel of the R&S FSW. If no additional options are installed, this is the only available input source.

Input Coupling....71
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YIG-Preselector....72

Input Coupling

The RF input of the R&S FSW can be coupled by alternating current (AC) or direct current (DC).

AC coupling blocks any DC voltage from the input signal. This is the default setting to prevent damage to the instrument. Very low frequencies in the input signal may be distorted.

However, some specifications require DC coupling. In this case, you must protect the instrument from damaging DC input voltages manually. For details, refer to the data sheet.

Remote command:

`INPut:COUPling` on page 156

Impedance

The reference impedance for the measured levels of the R&S FSW can be set to 50 Ω or 75 Ω.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a 75 Ω adapter of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Remote command:
`INPut:IMPedance` on page 157

High-Pass Filter 1...3 GHz
Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires option R&S FSW-B13.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Remote command:
`INPut:FILTer:HPASs[:STATe]` on page 156

YIG-Preselector
Activates or deactivates the YIG-preselector.

An internal YIG-preselector at the input of the R&S FSW ensures that image frequencies are rejected. However, this is only possible for a restricted bandwidth. In order to use the maximum bandwidth for signal analysis you can deactivate the YIG-preselector at the input of the R&S FSW, which may lead to image-frequency display.

Note that the YIG-preselector is active only on frequencies greater than 8 GHz. Therefore, switching the YIG-preselector on or off has no effect if the frequency is below that value.

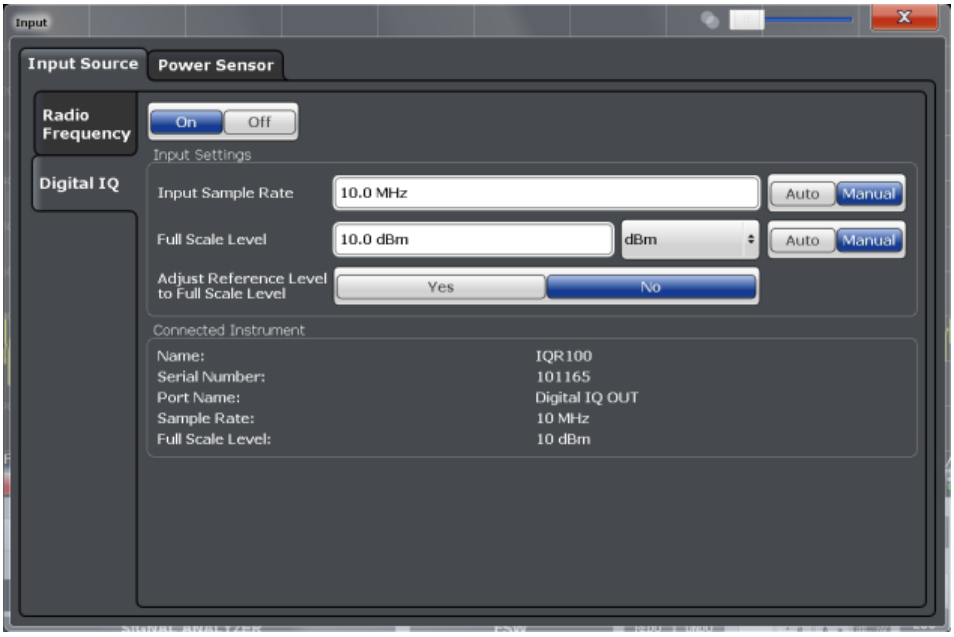
Note:
For the following measurements, the YIG-Preselector is off by default (if available).
- I/Q Analyzer (and thus in all applications in MSRA operating mode)
- Multi-Carrier Group Delay
- GSM
- VSA

`INPut:FILTer:YIG[:STATe]` on page 156

6.4.1.2 Digital I/Q Input Settings

The following settings and functions are available to provide input via the Digital Baseband Interface (R&S FSW-B17) in the applications that support it.

They can be configured via the INPUT/OUTPUT key, in the "Input" dialog box.



For more information see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Digital I/Q Input State....73
Input Sample Rate....73
Full Scale Level....73
Adjust Reference Level to Full Scale Level....74
Connected Instrument....74
DigIConf....74

Digital I/Q Input State
Enables or disable the use of the "Digital IQ" input source for measurements. "Digital IQ" is only available if the Digital Baseband Interface (R&S FSW-B17) is installed.

Remote command:
`INPut:SELect` on page 157

Input Sample Rate
Defines the sample rate of the digital I/Q signal source. This sample rate must correspond with the sample rate provided by the connected device, e.g. a generator.

If "Auto" is selected, the sample rate is adjusted automatically by the connected device.

The allowed range is from 100 Hz to 10 GHz.

Remote command:
`INPut:DIQ:SRATe` on page 160
`INPut:DIQ:SRATe:AUTO` on page 161

Full Scale Level
The "Full Scale Level" defines the level and unit that should correspond to an I/Q sample with the magnitude "1".

If "Auto" is selected, the level is automatically set to the value provided by the connected device.

Remote command:
INPut:DIQ:RANGe[:UPPer] on page 160
INPut:DIQ:RANGe[:UPPer]:UNIT on page 160
INPut:DIQ:RANGe[:UPPer]:AUTO on page 159

Adjust Reference Level to Full Scale Level
If enabled, the reference level is adjusted to the full scale level automatically if any change occurs.

Remote command:
INPut:DIQ:RANGe:COUPling on page 160

Connected Instrument
Displays the status of the Digital Baseband Interface connection.

If an instrument is connected, the following information is displayed:

- Name and serial number of the instrument connected to the Digital Baseband Interface
- Used port
- Sample rate of the data currently being transferred via the Digital Baseband Interface
- Level and unit that corresponds to an I/Q sample with the magnitude "1" (Full Scale Level), if provided by connected instrument

Remote command:
INPut:DIQ:CDEVice on page 158

DigIConf
Starts the optional R&S DigIConf application. This softkey is available in the In-/Output menu, but only if the optional software is installed.

Note that R&S DigIConf requires a USB connection (not LAN!) from the R&S FSW to the R&S EX-IQ-BOX in addition to the Digital Baseband Interface (R&S FSW-B17) connection. R&S DigIConf version 2.20.360.86 Build 170 or higher is required.

To return to the R&S FSW application, press any key on the front panel. The R&S FSW application is displayed with the "Input/Output" menu, regardless of which key was pressed.

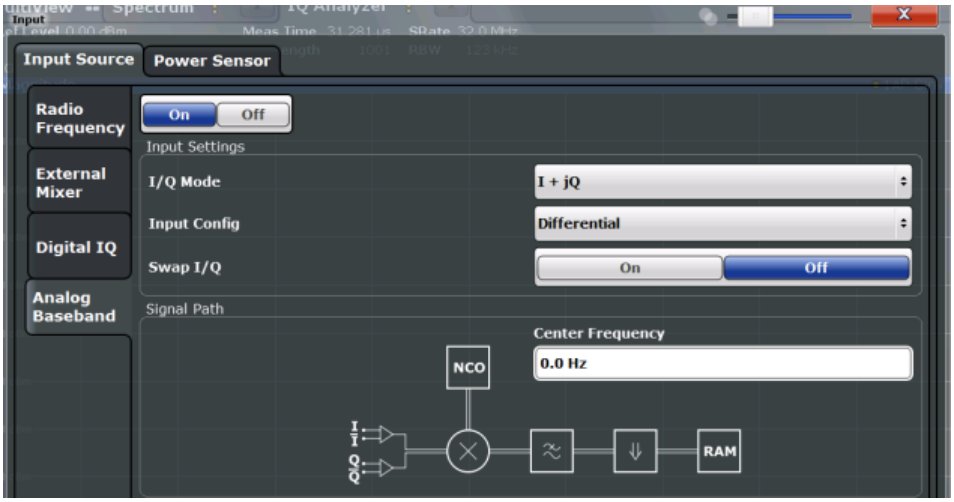
For details on the R&S DigIConf application, see the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Note: If you close the R&S DigIConf window using the "Close" icon, the window is minimized, not closed.
If you select the "File > Exit" menu item in the R&S DigIConf window, the application is closed. Note that in this case the settings are lost and the EX-IQ-BOX functionality is no longer available until you restart the application using the "DigIConf" softkey in the R&S FSW once again.

6.4.1.3 Analog Baseband Input Settings

The following settings and functions are available to provide input via the Analog Baseband Interface (R&S FSW-B71) in the applications that support it.

They can be configured via the INPUT/OUTPUT key, in the "Input" dialog box.



For more information on the Analog Baseband Interface (R&S FSW-B71) see the R&S FSW I/Q Analyzer and I/Q Input User Manual.

Analog Baseband Input State....75
I/Q Mode....75
Input configuration....76
Swap I/Q....76
Center Frequency....76

Analog Baseband Input State
Enables or disable the use of the "Analog Baseband" input source for measurements. "Analog Baseband" is only available if the Analog Baseband Interface (R&S FSW-B71) is installed.

Remote command:
`INPut:SELect` on page 157

I/Q Mode
Defines the format of the input signal.

"I + jQ" The input signal is filtered and resampled to the sample rate of the application.
Two inputs are required for a complex signal, one for the in-phase component, and one for the quadrature component.

"I Only / Low IF I"
The input signal at the BASEBAND INPUT I connector is filtered and resampled to the sample rate of the application.
If the center frequency is not 0, the input signal is down-converted first (**Low IF I**).

"Q Only / Low IF Q"
The input signal at the BASEBAND INPUT Q connector is filtered and resampled to the sample rate of the application.
If the center frequency is not 0, the input signal is down-converted first (**Low IF Q**).

Remote command:
`INPut:IQ:TYPE` on page 162

Input configuration
Defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 simple-ended lines.

Note: Both single-ended and differential probes are supported as input; however, since only one connector is occupied by a probe, the "Single-ended" setting must be used for all probes.

"Differential" I, Q and inverse I,Q data

"Single Ended" I, Q data only

Remote command:
`INPut:IQ:BALanced[:STATe]` on page 161

Swap I/Q
Activates or deactivates the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the R&S FSW can do the same to compensate for it.

Tip: Try this function if the TSC can not be found.

On	I and Q signals are interchanged Inverted sideband, Q+j*I
Off	I and Q signals are not interchanged Normal sideband, I+j*Q

Remote command:
`[SENSe:]SWAPiq` on page 163

Center Frequency
Defines the center frequency for analog baseband input.

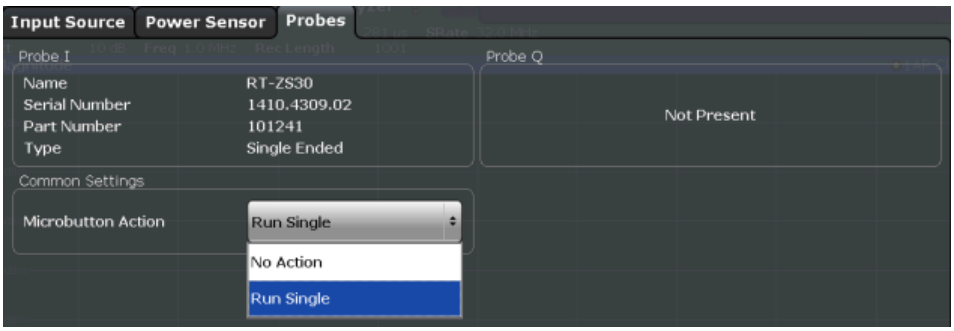
For real-type baseband input (I or Q only), the center frequency is always 0 Hz.

Note: If the analysis bandwidth to either side of the defined center frequency exceeds the minimum frequency (0 Hz) or the maximum frequency (40 MHz/80 MHz), an error is displayed. In this case, adjust the center frequency or the analysis bandwidth.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 167

6.4.1.4 Probe Settings

Probes are configured in a separate tab on the "Input" dialog box which is displayed when you select the INPUT/OUTPUT key and then "Input Source Config".



For each possible probe connector (Baseband Input I, Baseband Input Q), the detected type of probe, if any, is displayed. The following information is provided for each connected probe:

- Probe name
- Serial number
- R&S part number
- Type of probe ("Differential", "Single Ended")

For general information on the R&S®RTO probes, see the device manuals.

Microbutton Action.....77

Microbutton Action
Active R&S probes (except for RT-ZS10E) have a configurable microbutton on the probe head. By pressing this button, you can perform an action on the instrument directly from the probe.

Select the action that you want to start from the probe:

"Run single" Starts one data acquisition.

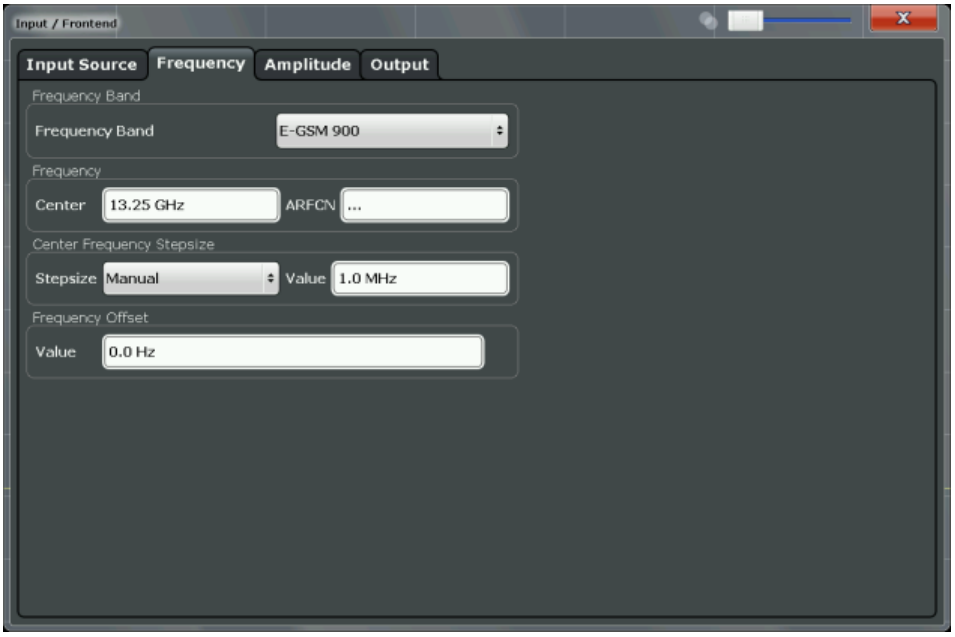
"No action" Prevents unwanted actions due to unintended usage of the microbutton.

Remote command:
`[SENSe:]PROBe<p>:SETup:MODE` on page 164

6.4.2 Frequency Settings

Frequency settings can be configured via the "Frequency" dialog box, which is displayed when you do one of the following:

- Select the FREQ key and then the "Frequency Config" softkey.
- Select the "Frequency" tab in the "Input/Frontend Settings" dialog box.



Frequency Band....78
Center Frequency....79
ARFCN....79
Center Frequency Stepsize....79
Frequency Offset....79

Frequency Band

The frequency band defines the frequency range used to transmit the signal.

For details see "Frequency bands and channels" on page 33.

The following frequency bands are supported:

- T-GSM 380
- T-GSM 410
- GSM 450
- GSM 480
- GSM 710
- GSM 750
- T-GSM 810
- GSM 850
- P-GSM 900
- E-GSM 900
- R-GSM 900
- T-GSM 900
- DCS 1800
- PCS 1900

The default frequency band is "E-GSM 900".

Remote command:

`CONFigure[:MS]:NETWork[:TYPE]` on page 144

`CONFigure[:MS]:NETWork:FREQuency:BAND` on page 143

Center Frequency
Specifies the center frequency of the signal to be measured. If the frequency is modified, the "ARFCN" is updated accordingly (see ARFCN).

This setting is not available if the Digital Baseband Interface (R&S FSW-B17) is active.

Remote command:
`[SENSe:]FREQuency:CENTer` on page 167

ARFCN
Defines the Absolute Radio Frequency Channel Number (ARFCN). The Center Frequency is adapted accordingly.

Possible values are in the range from 0 to 1023; however, some values may not be allowed depending on the selected Frequency Band.

This setting is not available if the Digital Baseband Interface (R&S FSW-B17) is active.

Remote command:
`CONFigure[:MS]:ARFCn` on page 167

Center Frequency Stepsize
Defines the step size by which the center frequency is increased or decreased when the arrow keys are pressed. When you use the rotary knob the center frequency changes in steps of only 1/10 of the "Center Frequency Stepsize".

The step size can be coupled to another value or it can be manually set to a fixed value.

"= Center" Sets the step size to the value of the center frequency. The used value is indicated in the "Value" field.

"Manual" Defines a fixed step size for the center frequency. Enter the step size in the "Value" field.

Remote command:
`[SENSe:]FREQuency:CENTer:STEP` on page 168

Frequency Offset
Shifts the displayed frequency range along the x-axis by the defined offset.

This parameter has no effect on the R&S FSW hardware, or on the captured data or on data processing. It is simply a manipulation of the final results in which absolute frequency values are displayed. Thus, the x-axis of a spectrum display is shifted by a constant offset if it shows absolute frequencies, but not if it shows frequencies relative to the signal's center frequency.

A frequency offset can be used to correct the display of a signal that is slightly distorted by the measurement setup, for example.

The allowed values range from -100 GHz to 100 GHz. The default setting is 0 Hz.

Remote command:
`[SENSe:]FREQuency:OFFSet` on page 169

6.4.3 Amplitude Settings

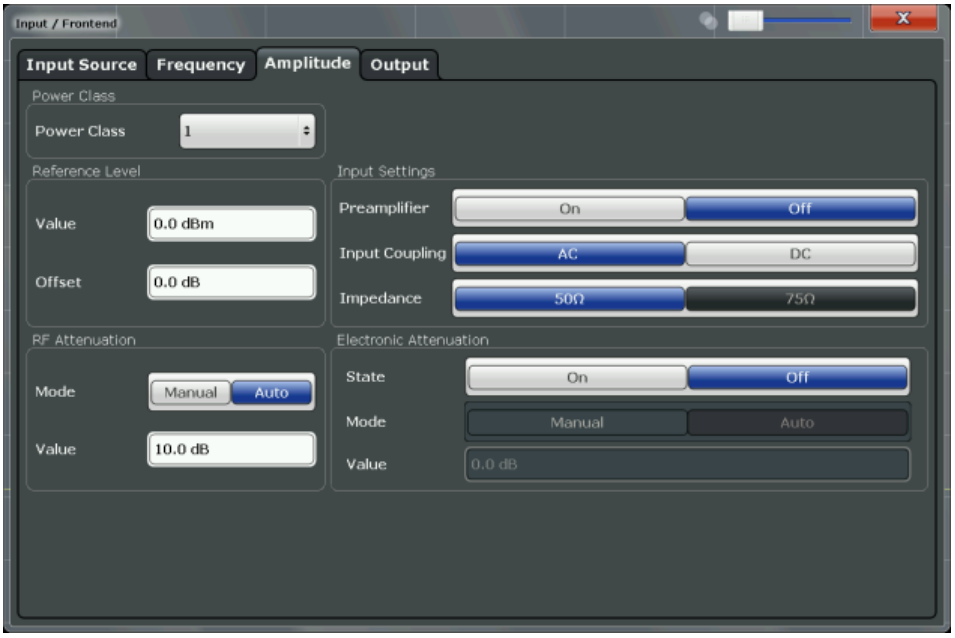
Amplitude settings affect the y-axis values.

To configure the amplitude settings

Amplitude settings can be configured via the AMPT key or in the "Amplitude" dialog box.

► To display the "Amplitude" dialog box, do one of the following:

- Select "Input/Frontend" from the "Overview" and then select the "Amplitude" tab.
- Select the AMPT key and then the "Amplitude Config" softkey.



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Mechanical Attenuation....81
└ Attenuation Mode / Value....81
Using Electronic Attenuation (Option B25)....82
Input Settings....82
└ Preamplifier (option B24)....82

Power Class

The following power classes are supported:

- 1, …, 8 (BTS)
- 1, …,5 (MS: GMSK)
- E1, E2, E3 (MS: all except GMSK)
- M1, M2, M3 (Micro BTS)
- P1 (Pico BTS)

The default power class is 2.

Remote command:

`CONFigure[:MS]:POWer:CLASs` on page 145

Reference Level
Defines the expected maximum reference level. Signal levels above this value may not be measured correctly, which is indicated by the "IF OVLD" status display.

The reference level is also used to scale power diagrams; the reference level is then used as the maximum on the y-axis.

Since the R&S FSW hardware is adapted according to this value, it is recommended that you set the reference level close above the expected maximum signal level to ensure an optimum measurement (no compression, good signal-to-noise ratio).

Note that the "Reference Level" value ignores the Shifting the Display (Offset). It is important to know the actual power level the R&S FSW must handle.

Remote command:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel` on page 170

Shifting the Display (Offset) ← Reference Level
Defines an arithmetic level offset. This offset is added to the measured level irrespective of the selected unit. The scaling of the y-axis is changed accordingly.

Define an offset if the signal is attenuated or amplified before it is fed into the R&S FSW so the application shows correct power results. All displayed power level results will be shifted by this value.

Note, however, that the Reference Level value ignores the "Reference Level Offset". It is important to know the actual power level the R&S FSW must handle.

To determine the required offset, consider the external attenuation or gain applied to the input signal. A positive value indicates that an attenuation took place (R&S FSW increases the displayed power values) , a negative value indicates an external gain (R&S FSW decreases the displayed power values).

The setting range is ±200 dB in 0.01 dB steps.

Remote command:
`DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet` on page 170

Mechanical Attenuation
Defines the mechanical attenuation for RF input.

Attenuation Mode / Value ← Mechanical Attenuation
The RF attenuation can be set automatically as a function of the selected reference level (Auto mode). This ensures that the optimum RF attenuation is always used. It is the default setting. By default and when Using Electronic Attenuation (Option B25) is not available, mechanical attenuation is applied.

In "Manual" mode, you can set the RF attenuation in 1 dB steps (down to 0 dB, also using the rotary knob). Other entries are rounded to the next integer value. The range is specified in the data sheet. If the defined reference level cannot be set for the defined RF attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed.

NOTICE! Risk of hardware damage due to high power levels. When decreasing the attenuation manually, ensure that the power level does not exceed the maximum level allowed at the RF input, as an overload may lead to hardware damage.

Remote command:
`INPut:ATTenuation` on page 171
`INPut:ATTenuation:AUTO` on page 172

Using Electronic Attenuation (Option B25)
If option R&S FSW-B25 is installed, you can also activate an electronic attenuator.

In "Auto" mode, the settings are defined automatically; in "Manual" mode, you can define the mechanical and electronic attenuation separately.

Note: Electronic attenuation is not available for stop frequencies (or center frequencies in zero span) >13.6 GHz.
In "Auto" mode, RF attenuation is provided by the electronic attenuator as much as possible to reduce the amount of mechanical switching required. Mechanical attenuation may provide a better signal-to-noise ratio, however.

When you switch off electronic attenuation, the RF attenuation is automatically set to the same mode (auto/manual) as the electronic attenuation was set to. Thus, the RF attenuation may be set to automatic mode, and the full attenuation is provided by the mechanical attenuator, if possible.

Both the electronic and the mechanical attenuation can be varied in 1 dB steps. Other entries are rounded to the next lower integer value.

If the defined reference level cannot be set for the given attenuation, the reference level is adjusted accordingly and the warning "Limit reached" is displayed in the status bar.

Remote command:
`INPut:EATT:STATe` on page 172
`INPut:EATT:AUTO` on page 172
`INPut:EATT` on page 172

Input Settings
Some input settings affect the measured amplitude of the signal, as well.

For details see chapter 6.4.1, "Input Source Settings", on page 70.

Preamplifier (option B24) ← Input Settings
If option R&S FSW-B24 is installed, a preamplifier can be activated for the RF input signal.

For R&S FSW 26 models, the input signal is amplified by 30 dB if the preamplifier is activated.

For R&S FSW 8 or 13 models, the following settings are available:

You can use a preamplifier to analyze signals from DUTs with low input power.

"Off" Deactivates the preamplifier.

"15 dB" The RF input signal is amplified by about 15 dB.

"30 dB" The RF input signal is amplified by about 30 dB.

Remote command:
`INPut:GAIN:STATe` on page 170
`INPut:GAIN[:VALue]` on page 170

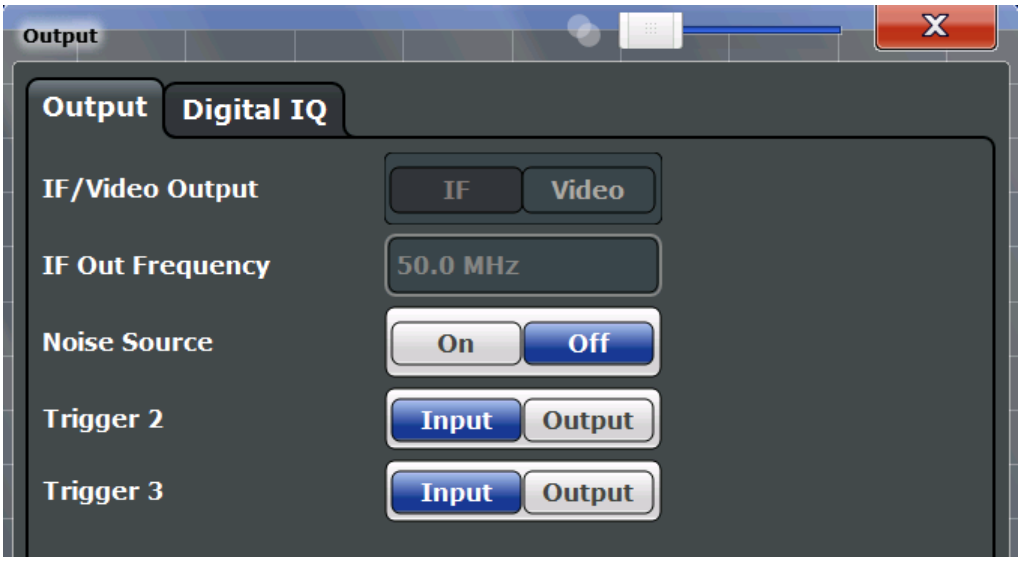
6.4.4 Output Settings

The R&S FSW can provide output to special connectors for other devices.

For details on connectors refer to the R&S FSW Getting Started manual, "Front / Rear Panel View" chapters.

How to provide trigger signals as output is described in detail in the R&S FSW User Manual.

Output settings can be configured via the INPUT/OUTPUT key or in the "Outputs" dialog box.



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└ Output Type....84
└ Level....84
└ Pulse Length....84
└ Send Trigger....85

Noise Source
Switches the supply voltage for an external noise source on or off.

External noise sources are useful when you are measuring power levels that fall below the noise floor of the R&S FSW itself, for example when measuring the noise level of a DUT.

Remote command:
DIAGnostic:SERVice:NSOurce on page 166

Trigger 2/3
Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. No further trigger parameters are available for the connector.

"Output" The R&S FSW sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
OUTPut:TRIGger<port>:LEVel on page 178
OUTPut:TRIGger<port>:DIRection on page 178

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSW triggers.

"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the STATus:OPERation register (bit 5), as well as by a low level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when user selects "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
OUTPut:TRIGger<port>:OTYPe on page 179

Level ← Output Type ← Trigger 2/3
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
OUTPut:TRIGger<port>:LEVel on page 178

Pulse Length ← Output Type ← Trigger 2/3
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
OUTPut:TRIGger<port>:PULSe:LENGth on page 180

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

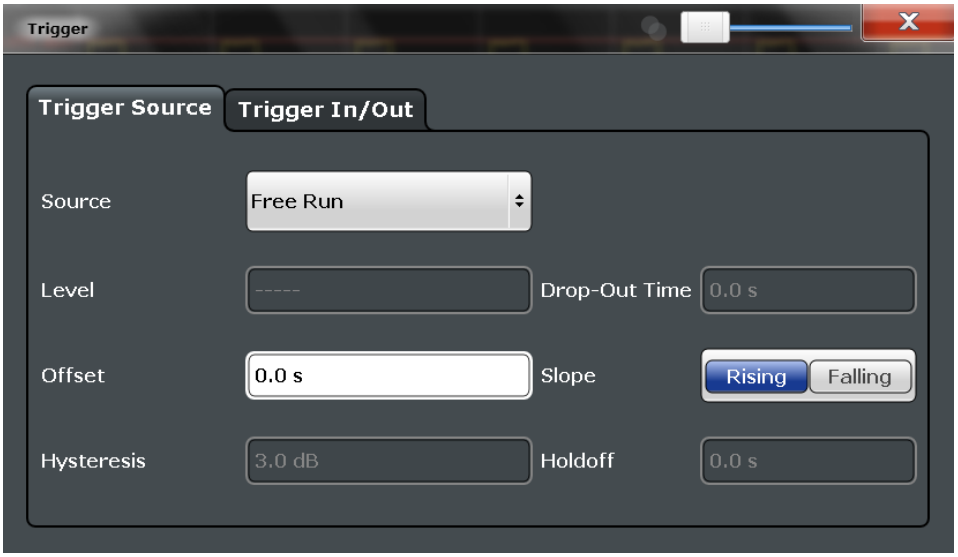
Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 179

6.5 Trigger Settings

Trigger settings determine when the input signal is measured.

Trigger settings can be configured in the "Trigger" dialog box, which is displayed when you do one of the following:

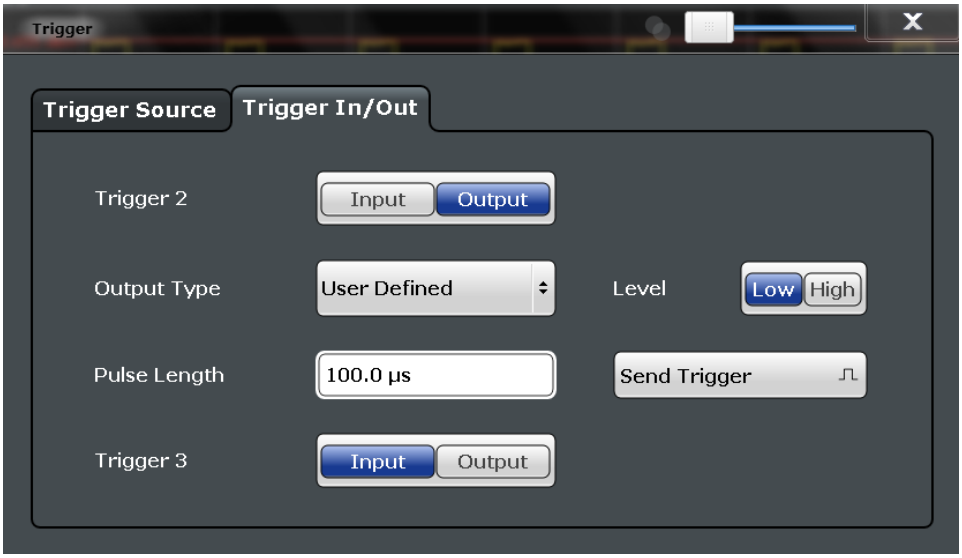
- Press the TRIG key and then select the "Trigger Config" softkey.
- In the "Overview", select the "Trigger" button.



The GSM measurements can be performed in "Free Run" (untriggered) mode; however, an external trigger or a power trigger can speed up measurements.

For more information see chapter 5.5, "Trigger settings", on page 39.

External triggers from one of the TRIGGER INPUT/OUTPUT connectors on the R&S FSW are configured in a separate tab of the dialog box.



Note that gating is not available for GSM measurements.

For step-by-step instructions on configuring triggered measurements, see the R&S FSW User Manual.

Trigger Settings....86
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└ External Trigger 1/2/3....87
└ IQ Power....87
└ IF Power....88
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└ Slope....89
└ Hysteresis....89
└ Trigger Holdoff....89
Trigger 2/3....89
└ Output Type....90
└ Level....90
└ Pulse Length....90
└ Send Trigger....90

Trigger Settings
The trigger settings define the beginning of a measurement.

Trigger Source ← Trigger Settings
Defines the trigger source. If a trigger source other than "Free Run" is set, "TRG" is displayed in the channel bar and the trigger source is indicated.

Note: Trigger source for MSRA Master.

Any trigger source other than "Free Run" defined for the MSRA Master is ignored when determining the frame start in the R&S FSW GSM application (see chapter 5.5, "Trigger settings", on page 39). For this purpose, the trigger is considered to be in "Free Run" mode.

Remote command:
TRIGger[:SEQuence]:SOURce on page 177

Free Run ← Trigger Source ← Trigger Settings
No trigger source is considered. Data acquisition is started manually or automatically and continues until stopped explicitely.

Remote command:
TRIG:SOUR IMM, see TRIGger[:SEQuence]:SOURce on page 177

External Trigger 1/2/3 ← Trigger Source ← Trigger Settings
Data acquisition starts when the TTL signal fed into the specified input connector (on the front or rear panel) meets or exceeds the specified trigger level.

(See "Trigger Level" on page 88).

Note: The "External Trigger 1" softkey automatically selects the trigger signal from the TRIGGER INPUT connector on the front panel.

For details see the "Instrument Tour" chapter in the R&S FSW Getting Started manual.

"External Trigger 1"
Trigger signal from the TRIGGER INPUT connector on the front panel.

"External Trigger 2"
Trigger signal from the TRIGGER INPUT/OUTPUT connector on the front panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 84).

"External Trigger 3"
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector on the rear panel.
Note: Connector must be configured for "Input" in the "Outputs" configuration (see "Trigger 2/3" on page 84).

Remote command:
TRIG:SOUR EXT, TRIG:SOUR EXT2, TRIG:SOUR EXT3
See TRIGger[:SEQuence]:SOURce on page 177

IQ Power ← Trigger Source ← Trigger Settings
This trigger source is not available if the optional Digital Baseband Interface (R&S FSW-B17) or Analog Baseband Interface (R&S FSW-B71) is used for input.

Triggers the measurement when the magnitude of the sampled I/Q data exceeds the trigger threshold.

Remote command:
TRIG:SOUR IQP, see TRIGger[:SEQuence]:SOURce on page 177

IF Power ← Trigger Source ← Trigger Settings
The R&S FSW starts capturing data as soon as the trigger threshold is exceeded around the third intermediate frequency.

For frequency sweeps, the third IF represents the start frequency. The trigger bandwidth at the third IF depends on the RBW and sweep type.

For measurements on a fixed frequency (e.g. zero span or I/Q measurements), the third IF represents the center frequency.

The trigger threshold depends on the defined trigger level, as well as on the RF attenuation and preamplification. For details on available trigger levels and trigger bandwidths see the data sheet.

This trigger source is only available for RF input.

Remote command:
`TRIG:SOUR IFP`, see `TRIGger[:SEQuence]:SOURce` on page 177

RF Power ← Trigger Source ← Trigger Settings
Defines triggering of the measurement via signals which are outside the displayed measurement range.

For this purpose the instrument uses a level detector at the first intermediate frequency. The input signal must be in the frequency range between 500 MHz and 8 GHz. The resulting trigger level at the RF input depends on the RF attenuation and preamplification. For details on available trigger levels see the data sheet.

Note: If the input signal contains frequencies outside of this range (e.g. for fullspan measurements), the sweep may be aborted and a message indicating the allowed input frequencies is displayed in the status bar.

A "Trigger Offset", "Trigger Polarity" and "Trigger Holdoff" (to improve the trigger stability) can be defined for the RF trigger, but no "Hysteresis".

Remote command:
`TRIG:SOUR RFP`, see `TRIGger[:SEQuence]:SOURce` on page 177

Trigger Level ← Trigger Settings
Defines the trigger level for the specified trigger source.

For details on supported trigger levels, see the data sheet.

Remote command:
`TRIGger[:SEQuence]:LEVel:IFPower` on page 175
`TRIGger[:SEQuence]:LEVel:IQPower` on page 176
`TRIGger[:SEQuence]:LEVel[:EXTernal<port>]` on page 175
`TRIGger[:SEQuence]:LEVel:RFPower` on page 176

Drop-Out Time ← Trigger Settings
Defines the time the input signal must stay below the trigger level before triggering again.

Remote command:
`TRIGger[:SEQuence]:DTIMe` on page 174

Trigger Offset ← Trigger Settings
Defines the time offset between the trigger event and the start of the sweep.

Note: When using an external trigger, the trigger offset is particularly important in order to detect the frame start correctly! (See chapter 5.5, "Trigger settings", on page 39.) The R&S FSW GSM application expects the trigger event to be the start of the "active part" in slot 0.

offset > 0:	Start of the sweep is delayed
offset < 0:	Sweep starts earlier (pre-trigger)

Remote command:
`TRIGger[:SEQuence]:HOLDoff[:TIME]` on page 174

Slope ← Trigger Settings
For all trigger sources except time you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Remote command:
`TRIGger[:SEQuence]:SLOPe` on page 177

Hysteresis ← Trigger Settings
Defines the distance in dB to the trigger level that the trigger source must exceed before a trigger event occurs. Settting a hysteresis avoids unwanted trigger events caused by noise oscillation around the trigger level.

This setting is only available for "IF Power" trigger sources. The range of the value is between 3 dB and 50 dB with a step width of 1 dB.

Remote command:
`TRIGger[:SEQuence]:IFPower:HYSTeresis` on page 174

Trigger Holdoff ← Trigger Settings
Defines the minimum time (in seconds) that must pass between two trigger events. Trigger events that occur during the holdoff time are ignored.

Remote command:
`TRIGger[:SEQuence]:IFPower:HOLDoff` on page 174

Trigger 2/3
Defines the usage of the variable TRIGGER INPUT/OUTPUT connectors, where:

"Trigger 2": TRIGGER INPUT/OUTPUT connector on the front panel

"Trigger 3": TRIGGER 3 INPUT/ OUTPUT connector on the rear panel

(Trigger 1 is INPUT only.)

Note: Providing trigger signals as output is described in detail in the R&S FSW User Manual.

"Input" The signal at the connector is used as an external trigger source by the R&S FSW. No further trigger parameters are available for the connector.

"Output" The R&S FSW sends a trigger signal to the output connector to be used by connected devices.
Further trigger parameters are available for the connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 178
`OUTPut:TRIGger<port>:DIRection` on page 178

Output Type ← Trigger 2/3
Type of signal to be sent to the output

"Device Triggered" (Default) Sends a trigger when the R&S FSW triggers.

"Trigger Armed" Sends a (high level) trigger when the R&S FSW is in "Ready for trigger" state.
This state is indicated by a status bit in the `STATus:OPERation` register (bit 5), as well as by a low level signal at the AUX port (pin 9).

"User Defined" Sends a trigger when user selects "Send Trigger" button.
In this case, further parameters are available for the output signal.

Remote command:
`OUTPut:TRIGger<port>:OTYPe` on page 179

Level ← Output Type ← Trigger 2/3
Defines whether a constant high (1) or low (0) signal is sent to the output connector.

Remote command:
`OUTPut:TRIGger<port>:LEVel` on page 178

Pulse Length ← Output Type ← Trigger 2/3
Defines the length of the pulse sent as a trigger to the output connector.

Remote command:
`OUTPut:TRIGger<port>:PULSe:LENGth` on page 180

Send Trigger ← Output Type ← Trigger 2/3
Sends a user-defined trigger to the output connector immediately. Note that the trigger pulse level is always opposite to the constant signal level defined by the output "Level" setting, e.g. for "Level = High", a constant high signal is output to the connector until the "Send Trigger" button is selected. Then, a low pulse is sent.

Which pulse level will be sent is indicated by a graphic on the button.

Remote command:
`OUTPut:TRIGger<port>:PULSe:IMMediate` on page 179

6.6 Data Acquisition

You must define how much and how often data is captured from the input signal.

The settings in this dialog box are available when you do one of the following:

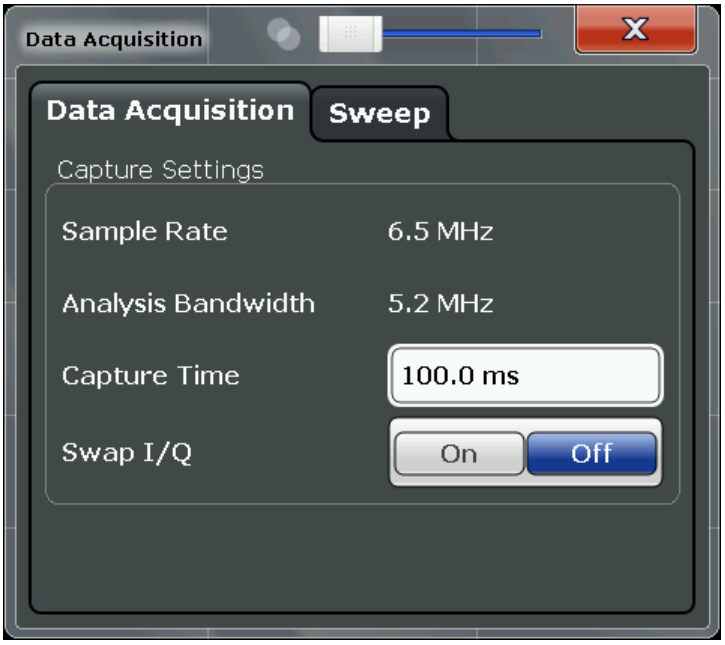
- Select the "Data Acquisition" button from the "Overview".

- Press the BW, SPAN SWEEP, or MEAS CONFIG key, then the "Data Acquisition" softkey.

- Data Acquisition....91
- Sweep....93

6.6.1 Data Acquisition

The "Data Acquisition" settings define how long data is captured from the input signal by the R&S FSW GSM application.



Sample rate....91
Analysis Bandwidth....91
Capture Time....92
Capture Offset....92
Swap I/Q....92

Sample rate
The sample rate for I/Q data acquisition is indicated for reference only. It is a fixed value, depending on the frequency range to be measured (see also chapter 6.8.2, "Spectrum", on page 103).

Remote command:
`TRACe:IQ:SRATe?` on page 181

Analysis Bandwidth
The analysis bandwidth is indicated for reference only. It defines the flat, usable bandwidth of the final I/Q data. This value is dependent on the Frequency list and the defined signal source.

The following rule applies:

*analysis bandwidth = 0.8 * sample rate*

Note: MSRA operating mode. In MSRA operating mode, the MSRA Master is restricted to an input sample rate of 200 MHz.

Remote command:
`TRACe:IQ:BWIDth?` on page 181

Capture Time
Specifies the duration (and therefore the amount of data) to be captured in the capture buffer. If the capture time is too short, demodulation will fail.

Note: The duration of one GSM slot equals 15/26 ms = 0.576923 ms. The duration of one GSM frame (8 slots) equals 60/13 ms = 4.615384 ms.

Note: MSRA operating mode.
In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The "Capture Time" for the R&S FSW GSM application in MSRA mode defines the length of the **analysis interval**.

For details on the MSRA operating mode see the R&S FSW MSRA User Manual.

The "Capture Time" can also be defined using the softkey which is available from the SPAN, BW or SWEEP menus.

Remote command:
`[SENSe:]SWEep:TIME` on page 181

Capture Offset
This setting is only available for applications in **MSRA operating mode**. It has a similar effect as the trigger offset in other measurements: it defines the time offset between the capture buffer start and the start of the extracted application data. The offset must be a positive value, as the application can only analyze data that is contained in the capture buffer.

Remote command:
`[SENSe:]MSRA:CAPTure:OFFSet` on page 217

Swap I/Q
Activates or deactivates the inverted I/Q modulation. If the I and Q parts of the signal from the DUT are interchanged, the R&S FSW can do the same to compensate for it.

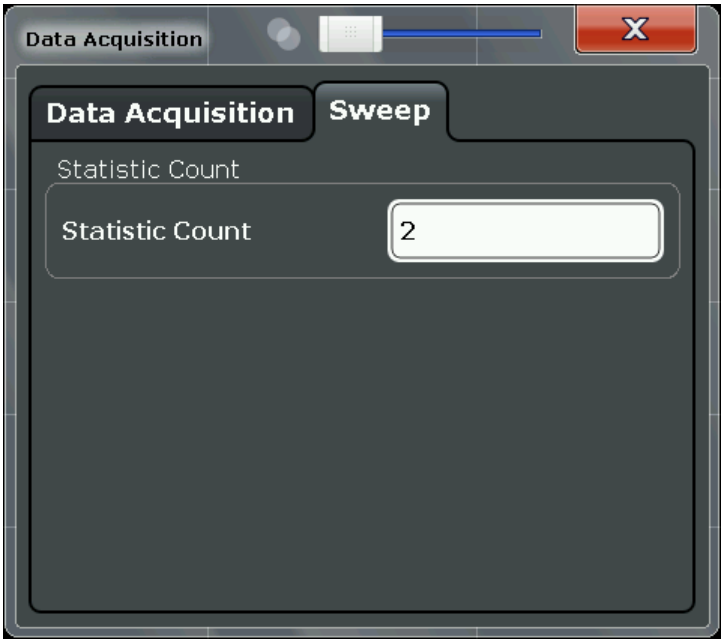
Tip: Try this function if the TSC can not be found.

On	I and Q signals are interchanged Inverted sideband, Q+j*I
Off	I and Q signals are not interchanged Normal sideband, I+j*Q

Remote command:
`[SENSe:]SWAPiq` on page 163

6.6.2 Sweep

The "Sweep" settings define how often data is captured from the input signal by the R&S FSW GSM application.



Statistic Count....93
Continuous Sweep/RUN CONT....93
Single Sweep/ RUN SINGLE....94
Continue Single Sweep....94
Refresh....94

Statistic Count
Defines the number of frames to be included in statistical evaluations. For measurements on the Slot to Measure, the same slot is evaluated in multiple frames, namely in the number specified by the "Statistic Count", for statistical evaluations.

The default value is 200 in accordance with the GSM standard.

For details on the impact of this value, see chapter 5.15, "Impact of the "Statistic Count"", on page 55.

Remote command:
`[SENSe:]SWEep:COUNt` on page 186

Continuous Sweep/RUN CONT
While the measurement is running, the "Continuous Sweep" softkey and the RUN CONT key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again. The results are not deleted until a new measurement is started.

Note: Sequencer. If the Sequencer is active, the "Continuous Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only

has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in continuous sweep mode is swept repeatedly. Furthermore, the RUN CONT key on the front panel controls the Sequencer, not individual sweeps. RUN CONT starts the Sequencer in continuous mode.

Remote command:
`INITiate:CONTinuous` on page 183

Single Sweep/ RUN SINGLE
While the measurement is running, the "Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Note: Sequencer. If the Sequencer is active, the "Single Sweep" softkey only controls the sweep mode for the currently selected channel; however, the sweep mode only has an effect the next time the Sequencer activates that channel, and only for a channel-defined sequence. In this case, a channel in single sweep mode is swept only once by the Sequencer.
Furthermore, the RUN SINGLE key on the front panel controls the Sequencer, not individual sweeps. RUN SINGLE starts the Sequencer in single mode.

If the Sequencer is off, only the evaluation for the currently displayed measurement channel is updated.

Remote command:
`INITiate[:IMMediate]` on page 184

Continue Single Sweep
While the measurement is running, the "Continue Single Sweep" softkey and the RUN SINGLE key are highlighted. The running measurement can be aborted by selecting the highlighted softkey or key again.

Remote command:
`INITiate:CONMeas` on page 183

Refresh
This function is only available if the Sequencer is deactivated and only for **MSRA applications**.

The data in the capture buffer is re-evaluated by the currently active application only. The results for any other applications remain unchanged.

This is useful, for example, after evaluation changes have been made or if a new sweep was performed from another application; in this case, only that application is updated automatically after data acquisition.

Remote command:
`INITiate:REFResh` on page 216

6.7 Demodulation

Demodulation settings determine how frames and slots are detected in the input signal and which slots are to be evaluated.

The "Demodulation" settings are available from the configuration "Overview".

The "Frame" and "Slot" settings are identical to those in the "Signal Description" dialog box, see chapter 6.3.1, "Frame and DUT Settings", on page 63 and chapter 6.3.2, "Slot Settings", on page 65.

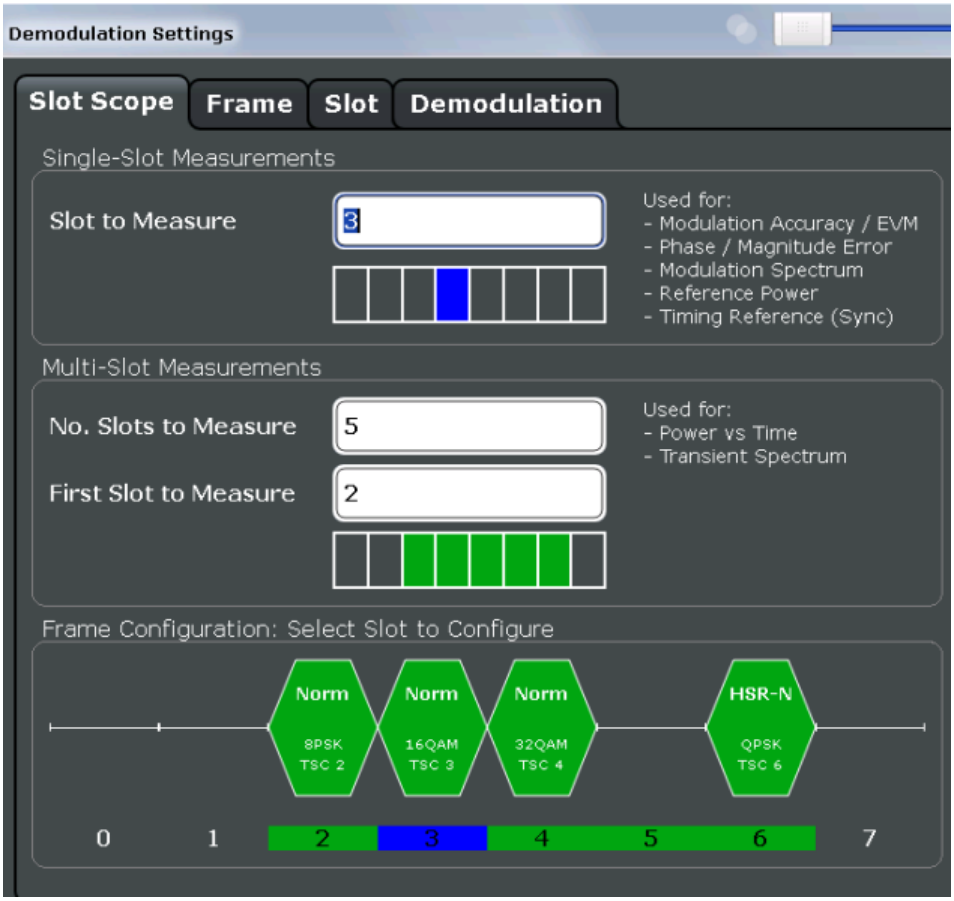
- Slot Scope.....95
- Demodulation Settings.....97

6.7.1 Slot Scope

The slot scope defines which slots are to be evaluated (see also chapter 5.6, "Defining the Scope of the Measurement", on page 40).

The settings in this dialog box are available when you do one of the following:

- In the "Overview", select the "Demodulation" button, then switch to the "Slot Scope" tab.
- Press the MEAS CONFIG key, then the "Slot Scope" softkey.



Slot to Measure....96
Number of Slots to measure....96
First Slot to measure....96
Frame Configuration: Select Slot to Configure....97

Slot to Measure
This parameter specifies the slot to be measured in single-slot measurements relative to the GSM frame boundary. The following rule applies:

$0 \leq$ Slot to Measure ≤ 7

The "Slot to Measure" is used as the (only) slot to measure in the following measurements: (see "First Slot to measure" on page 96)

- Modulation Accuracy
- EVM
- Phase Error
- Magnitude Error
- Modulation Spectrum
- Constellation

Furthermore, the "Slot to Measure" is used to measure the reference power for the following measurements:

- Power vs Time
- Modulation Spectrum
- Transient Spectrum

Finally, the "Slot to Measure" is used to measure the position of its TSC, which represents the timing reference for the Power vs Time mask (limit lines) of all slots.

See also chapter 5.6, "Defining the Scope of the Measurement", on page 40. For details on the measurement types see chapter 4, "Measurement Results", on page 15.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:MEASure` on page 188

Number of Slots to measure
This parameter specifies the "Number of Slots to measure" for the measurement interval of multi-slot measurements, i.e. the Power vs Time and Transient Spectrum measurements. Between 1 and 8 consecutive slots can be measured.

See also chapter 5.6, "Defining the Scope of the Measurement", on page 40.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:NOFSlots` on page 188

First Slot to measure
This parameter specifies the start of the measurement interval for mulit-slot measurements, i.e. Power vs Time and Transient Spectrum measurements, relative to the GSM frame boundary. The following conditions apply:

- First Slot to measure $\leq$ Slot to Measure
- Slot to Measure $\leq$ First Slot to measure + Number of Slots to measure -1

See also chapter 5.6, "Defining the Scope of the Measurement", on page 40.

Remote command:
`CONFigure[:MS]:CHANnel:MSLots:OFFSet` on page 188

Frame Configuration: Select Slot to Configure
This area shows a graphical representation of the configuration of each slot. Select a slot to display its "Slot" dialog box (see chapter 6.3.2, "Slot Settings", on page 65).

For active slots the following information is shown:

- The burst type, e.g. "Normal (NB)" for a normal burst.
- The modulation, e.g. GMSK.
- The training sequence TSC (and Set)

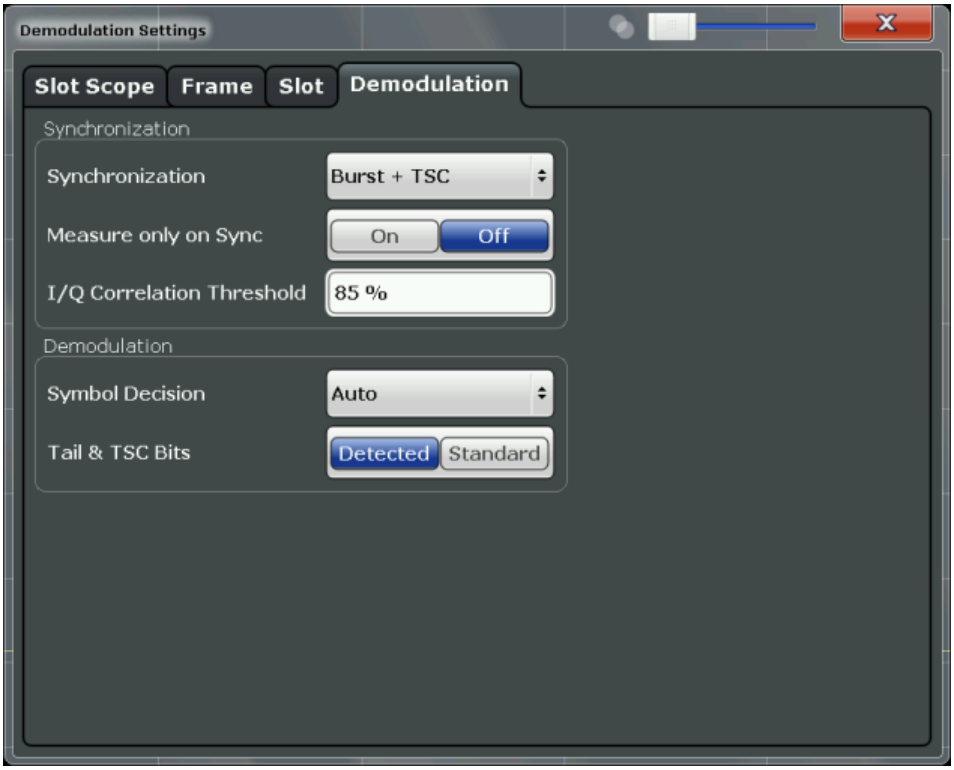
For details on how to interpret the graphic, see "Frame configuration and slot scope in the channel bar" on page 41.

6.7.2 Demodulation Settings

The demodulation settings provide additional information to optimize frame, slot and symbol detection.

The settings in this dialog box are available when you do the following:

- In the "Overview", select the "Demodulation" button, then switch to the "Demodulation" tab.



Synchronization....98
Measure only on Sync....99
I/Q Correlation Threshold....99
Symbol Decision....99
Tail & TSC Bits....100

Synchronization
Sets the synchronization mode of the R&S FSW GSM application.

"Burst+TSC" First search for the power profile (burst search) according to the frame configuration in the capture buffer. Second, inside the found bursts search for the TSC of the Slot to Measure as given in the frame configuration. "Burst +TSC" is usually faster than "TSC" for bursted signals.

"TSC" Search the capture buffer for the TSC of the Slot to Measure as given in the frame configuration. This mode corresponds to a correlation with the given TSC. This mode can be used for continuous (but framed) signals or bursted signals.

"Burst" Search for the power profile (burst search) according to the frame configuration in the capture buffer.
Note: For "Burst" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

"None" Do not synchronize at all. If an external or power trigger is chosen, the trigger instant corresponds to the frame start.
Tip: Manually adjust the trigger offset to move the burst to be analyzed under the mask in the "Power vs Time" measurement.
Note: For "None" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

Remote command:
`CONFigure[:MS]:SYNC:MODE` on page 189

Measure only on Sync
If activated (default), only results from frames (slots) where the Slot to Measure was found are displayed and taken into account in the averaging of the results. The behavior of this option depends on the value of the Synchronization parameter.

Remote command:
`CONFigure[:MS]:SYNC:ONLY` on page 190

I/Q Correlation Threshold
This threshold determines whether a burst is accepted if Measure only on Sync is activated. If the correlation value between the ideal I/Q signal of the given TSC and the measured TSC is below the I/Q correlation threshold, then the application reports "Sync not found" in the status bar. Additionally, such bursts are ignored if "Measure only on Sync" is activated.

Note: If the R&S FSW GSM application is configured to measure GMSK normal bursts, a threshold below 97% will also accept 8PSK normal bursts (with the same TSC) for analysis. In this case, activate Measure only on Sync and set the "I/Q Correlation Threshold" to 97%. This will exclude the 8PSK normal bursts from the analysis.

Remote command:
`CONFigure[:MS]:SYNC:IQCThreshold` on page 190

Symbol Decision
The symbol decision determines how the symbols are detected in the demodulator. Setting this parameter does not affect the demodulation of normal bursts with GMSK modulator. For normal bursts with 8PSK, 16QAM, 32QAM or AQPSK modulation, or higher symbol rate bursts with QPSK, 16QAM or 32QAM modulation, use this parameter to get a trade-off between performance (symbol error rate of the R&S FSW GSM application) and measurement speed.

"Auto" Automatically selects the symbol decision method.

"Linear" Linear symbol decision: Uses inverse filtering (a kind of zero-forcing filter) and a symbol-wise decision method. This method is recommended for high symbol to noise ratios, but not for higher symbol rate bursts with a narrow pulse. The inverse filter colors the noise inside the signal bandwidth and therefore is not recommended for narrow-band signals or signals with a low signal to noise ratio. Peaks in the "EVM vs Time" measurement (see "EVM" on page 16) may occur if the "Linear" symbol decision algorithm fails. In that case use the "Sequence" method. Linear is the fastest option.

"Sequence" Symbol decision via sequence estimation. This method uses an algorithm that minimizes the symbol errors of the entire burst. It requires that the tail bits in the analyzed signal are correct. It has a better performance (lower symbol error rate) compared to the "Linear" method, especially at low signal to noise ratios, but with a loss of measurement speed. This method is recommended for normal bursts with 16QAM or 32QAM modulation and for Higher Symbol Rate bursts with a narrow pulse.

Remote command:
`CONFigure[:MS]:DEMod:DECision` on page 190

Tail & TSC Bits
The demodulator in the R&S FSW GSM application requires the bits of the burst (tail, data, TSC, data, tail) to provide an ideal version of the measured signal. The "data" bits can be random and are typically not known inside the demodulator of the R&S FSW GSM application. "tail" and "TSC" bits are specified in the "Slot" dialog box (see "Training Sequence TSC / Sync" on page 68).

"Detected" The detected Tail and TSC bits are used to construct the ideal signal.

"Standard" The standard tail and TSC bits (as set in the "Slot" dialog box) are used to construct the ideal signal.
Using the standard bits can be advantageous to verify whether the device under test sends the correct tail and TSC bits. Incorrect bits would lead to peaks in the "EVM vs Time" trace (see "EVM" on page 16) at the positions of the incorrect bits.

Remote command:
`CONFigure[:MS]:DEMod:STDBits` on page 191

6.8 Measurement Settings

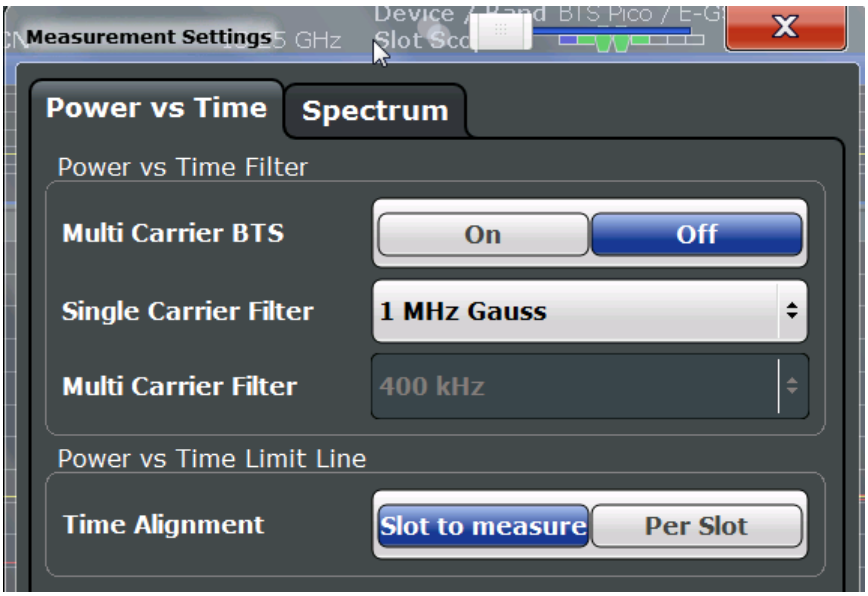
Measurement settings define how power or spectrum measurements are performed.

The settings in this dialog box are available when you do one of the following:

- In the "Overview", select the "Measurement" button.
- Press the MEAS CONFIG key, then the "Meas Settings" softkey.

6.8.1 Power vs Time

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see chapter 5.7.2, "Power vs Time Filter", on page 44). A limit line is available to determine if the power exceeds the limits defined by the standard in each slot.



Multicarrier BTS
This parameter informs the R&S FSW GSM application that the measured signal is a multicarrier signal. This function is only available if the "Device Type" is a "BTS" type (see "Device Type" on page 63).

Activating this checkbox has the following effects:

- An additional multicarrier filter is switched into the demodulation path of the R&S FSW GSM application. This filter can, for example, suppress up to six adjacent channels with a channel spacing of 600 kHz from the measured channel (at the set center frequency) and 30 dB higher power compared to the measured channel. This filter is also taken into account during the generation of the ideal (reference) signal in order to get meaningful EVM values. (Otherwise there would be an increase in EVM because the measured signal has a smaller bandwidth compared to the reference signal).
- Additional multicarrier parameters become available.

Remote command:
`CONFigure[:MS]:MCARrier:MCBTs` on page 154

Single Carrier PvT Filter
The PvT Filter controls the filter used to reduced the measurement bandwidth for single carrier "Power vs Time" measurements. The parameter is only available if "Multicarrier BTS" is switched off (see "Multicarrier BTS" on page 69).

The following single carrier PvT filters are supported:

"1 MHz Gauss"
default

"500 kHz Gauss"
for backwards compatibility to FS-K5

"600 kHz"
for backwards compatibility to FS-K5

Remote command:
`CONFigure:BURSt:PTEMplate:FILTer` on page 192

Multicarrier PvT Filter
Controls the filter used to reduced the measurement bandwidth for multicarrier "Power vs Time" measurements. The parameter is only available if "Multicarrier BTS" is switched on (see "Multicarrier BTS" on page 69).

For further details on filtering in the R&S FSW GSM application see chapter 5.7, "Overview of filters in the R&S FSW GSM application", on page 42.

The following filters are supported:

Note: The PvT filter is optimized to get smooth edges after filtering burst signals and to suppress adjacent, active channels.

"400 kHz" (default) Recommended for measurements with multi channels of equal power.

"300 kHz" Recommended for measurement scenarios where a total of six channels is active and the channel to be measured has a reduced power (e.g. 30 dB) compared to its adjacent channels.

Remote command:
`CONFigure[:MS]:MCARrier:FILTer` on page 193

Limit Line Time Alignment
Controls how the limit lines are aligned in a "Power vs Time" measurement graph (see "PvT Full Burst" on page 25). Limit lines are defined for each slot. The limit lines are time-aligned in each slot, based on the position of the TSC (the center of the TSC is the reference point). This parameter affects how the center of the TSC is determined for each slot:

- **Slot to measure** (default): For each slot the center of the TSC is derived from the measured center of the TSC of the Slot to Measure and the timeslot lengths specified in the standard (see "Timeslot length" in 3GPP TS 45.010 and "Equal Timeslot Length" on page 64).
- **Per Slot**: For each slot the center of the TSC is measured. This provides reasonable time-alignment if the slot lengths are not according to standard. Note that in this case the "Power vs Time" limit check may show "pass" even if the timeslot lengths are not correct according to the standard.

Note: The "Limit Time Alignment" also decides whether the "Delta to sync" values of the "Power vs Time" list result are measured (for "Limit Time Alignment" = "Per Slot") or if they are constant as defined by the 3PP standard (for "Limit Time Alignment" = "Slot to measure").

The R&S FSW GSM application offers a strictly standard-conformant, multiple-slot PvT limit line check. This is based on time alignment to a single specified slot (the "Slot to Measure") and allows the user to check for correct BTS timeslot alignment in the DUT, according to the GSM standard. In addition, a less stringent test which performs PvT limit line alignment on a per-slot basis ("Per Slot") is also available.

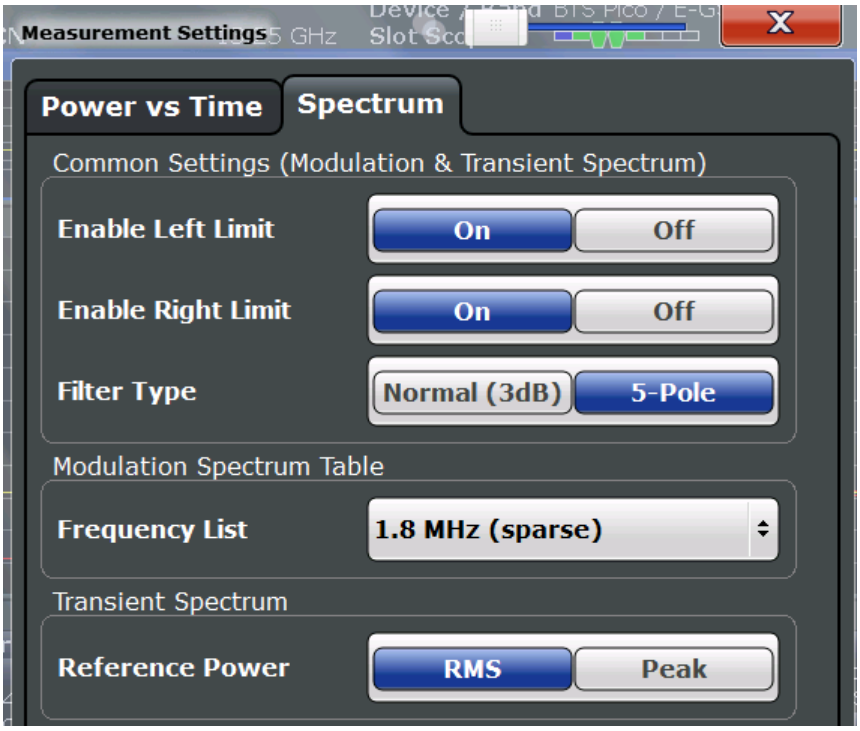
Note:

When measuring access bursts the parameter "Limit Time Alignment" should be set to "Per Slot", since the position of an access burst within a slot depends on the set timing advance of the DUT.

Remote command:
CONFigure:BURSt:PTEMplate:TALign on page 193

6.8.2 Spectrum

The modulation and transient spectrum measurements allow for further configuration.



Enable Left Limit/ Enable Right Limit....103
Filter Type....104
Modulation Spectrum Table: Frequency List....104
Transient Spectrum: Reference Power....104

Enable Left Limit/ Enable Right Limit
Controls whether the results for the frequencies to the left or to the right of the center frequency, or both, are considered in the limit check of the spectrum trace (spectrum graph measurement). This parameter effects the "Modulation Spectrum Graph" on page 20 and "Transient Spectrum Graph" on page 27 measurements.

Note: For measurements on multicarrier signals, using either the check on the left or right side only allows you to measure the spectrum of the left or right-most channel while ignoring the side where adjacent channels are located.

Remote command:
CONFigure:SPECtrum:LIMit:LEFT on page 194
CONFigure:SPECtrum:LIMit:RIGHt on page 195

Filter Type
Defines the filter type for the resolution filter for the "Modulation Spectrum" and "Transient Spectrum" measurements.

"Normal" 3 dB Gauss filter

"5-pole" according to the GSM standard

Remote command:
`[SENSe:]BANDwidth[:RESolution]:TYPE` on page 197

Modulation Spectrum Table: Frequency List
This setting is only required by the "Modulation Spectrum Table" evaluation (see "Modulation Spectrum Table" on page 22). In this evaluation, the spectrum of the signal at fixed frequency offsets is determined. The list of frequencies to be measured is defined by the standard. Additionally, sparse versions of the specified frequency lists with fewer intermediate frequencies are provided for quicker preliminary tests.

Note: Modulation RBW at 1800 kHz.
In previous R&S signal and spectrum analyzers, the modulation RBW at 1800 kHz was configurable. The R&S FSW configures the RBW (and VBW) internally according to the selected frequency list. For the "Modulation Spectrum Graph" both the RBW and VBW are set to 30 kHz; for the "Modulation Spectrum Table", they are set to 30 kHz for frequencies below 1800 kHz, and to 100 kHz for 1800 kHz and higher frequencies.

Note: The frequency list also determines the used sample rate, see "Sample rate" on page 91).

"1.8 MHz" The frequency list comprises offset frequencies up to 1.8 MHz from the carrier. The sample rate is 6.5 MHz.
In previous R&S signal and spectrum analyzers, this setting was referred to as "narrow".

"1.8 MHz (sparse)" More compact version of "1.8 MHz". The sample rate is 6.5 MHz.

"6 MHz" The frequency list comprises offset frequencies up to 6 MHz from the carrier. The sample rate is 19.5 MHz.
In previous R&S signal and spectrum analyzers, this setting was referred to as "wide".

"6 MHz (sparse)" More compact version of "6 MHz". The sample rate is 19.5 MHz.

Remote command:
`CONFigure:WSPectrum:MODulation:LIST:SELect` on page 196

Transient Spectrum: Reference Power
This setting is only required by the "Transient Spectrum" evaluation (see Transient Spectrum Graph).

In this evaluation, the power vs spectrum for all slots in the slot scope is evaluated and checked against a spectrum mask. To determine the relative limit values, a reference power is required. In order to detect irregularities, it is useful to define the peak power as a reference. However, the standard requires the reference power to be calculated from the RMS power.

Note:

To perform the measurement according to the 3GPP standard set the reference power to RMS and the Slot to Measure to the slot with the highest power.

See 3GPP TS 45.005, chapter "4 Transmitter characteristics ":

For GMSK modulation, the term output power refers to the measure of the power when averaged over the useful part of the burst (see annex B).

For QPSK, AQPSK, 8-PSK, 16-QAM and 32-QAM modulation, the term "output power" refers to a measure that, with sufficient accuracy, is equivalent to the long term average of the power when taken over the useful part of the burst as specified in 3GPP TS 45.002 with any fixed TSC and with random encrypted bits.

See 3GPP TS 51.021, chapter "6.5.2 Switching transients spectrum":

The reference power for relative measurements is the power measured in a bandwidth of at least 300 kHz for the TRX under test for the time slot in this test with the highest power.

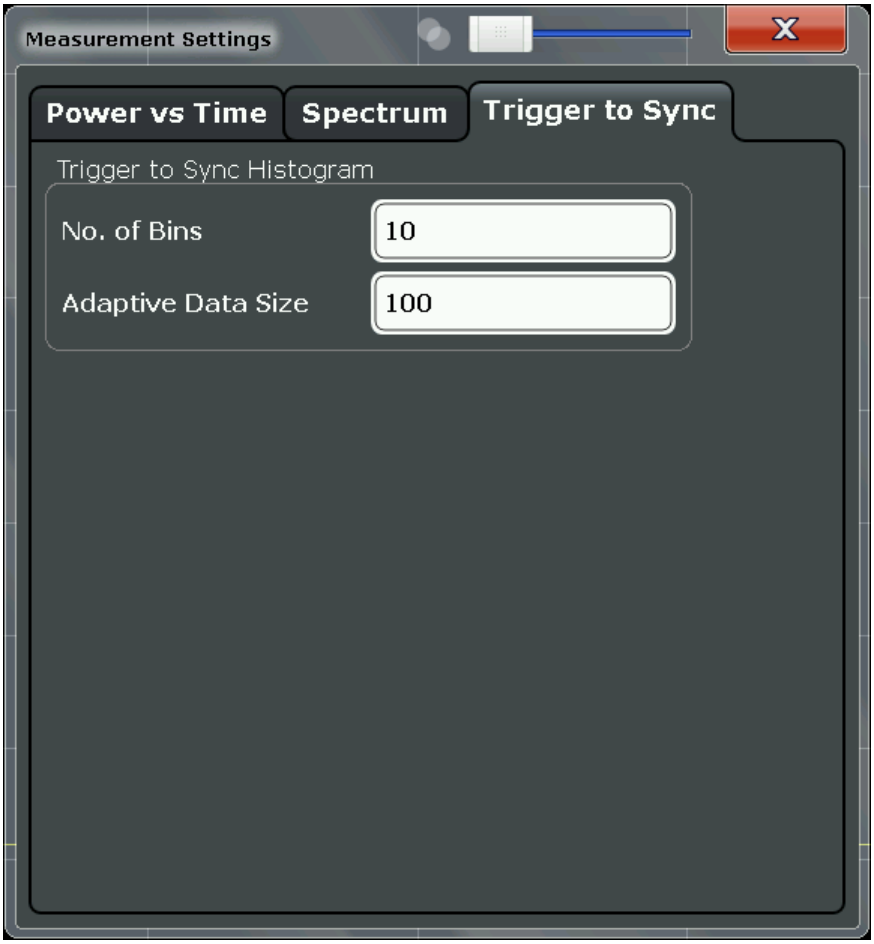
"RMS" (Default:) The reference power is the RMS power level measured over the useful part of the Slot to Measure and averaged according to the defined Statistic Count.

"Peak" The reference power is the peak power level measured over the selected slot scope (see chapter 6.7.1, "Slot Scope", on page 95) and its peak taken over Statistic Count measurements (GSM frames).

Remote command:
`CONFigure:SPECtrum:SWITching:TYPE` on page 195

6.8.3 Trigger to Sync

The Trigger to Sync measurement allows for further configuration.



No. of Bins
Specifies the number of bins for the histogram of the "Trigger to Sync" measurement.

For details see "Trigger to Sync Graph" on page 29.

Remote command:
`CONFigure:TRGS:NOFBins` on page 198

Adaptive Data Size
Specifies the number of measurements (I/Q captures) after which the x-axis of the "Trigger to Sync" histogram is adapted to the measured values and fixed for subsequent measurements.

Up to the defined number of measurements, the Trigger to Sync value is stored. When enough measurements have been performed, the x-axis is adapted to the value range of the stored results. For subsequent measurements, the result is no longer stored and the x-axis (and thus the dimensions of the bins) is maintained at the set range.

The higher the "Adaptive Data Size", the more precise the x-axis scaling.

For details see "Trigger to Sync Graph" on page 29.

Remote command:
`CONFigure:TRGS:ADPSize` on page 198

6.9 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

To activate the automatic adjustment of a setting, select the corresponding function in the AUTO SET menu or in the configuration dialog box for the setting, where available.

Setting the Reference Level Automatically (Auto Level).....107
Automatic Frame Configuration.....107
Automatic Trigger Offset.....108

Setting the Reference Level Automatically (Auto Level)
Automatically determines the optimal reference level for the current input data. At the same time, the internal attenuators and the preamplifier are adjusted so the signal-to-noise ratio is optimized, while signal compression, clipping and overload conditions are minimized.

In order to do so, a level measurement is performed to determine the optimal reference level.

This function is **not** available in **MSRA** mode.

Remote command:
`CONFigure[:MS]:AUTO:LEVel ONCE` on page 199

Automatic Frame Configuration
When activated, a single auto frame configuration measurement is performed.

Note: This function is **not** available in **MSRA** mode if the **Sequencer** is active.

The auto frame configuration measurement may take a long time, therefore it is deactivated by default. The following parameters are detected and automatically measured:

- Active slots
- Slot configuration (burst type, modulation, filter, TSC)
- Equal time slot length
- For VAMOS normal burst and GMSK: TSCs of set 1 and set 2
- For VAMOS normal burst and AQPSK: TSCs of both subchannels (restrictions see "Restriction for auto frame configuration" on page 37) and SCPIR

Note: The auto frame configuration typically does not work with frequency hopping systems, unless the trigger offset is set correctly. In this case, not every frame is populated by a modulated GSM signal. A workaround is to use auto frame configuration with a manually set trigger offset:

- Set "Synchronization" = "None"
- Set the trigger offset manually in the "Power vs Time" measurement.
- Set "Synchronization" back to "Burst + TSC" or "TSC".
- Press the "Auto Frame Config" softkey to run the auto frame configuration measurement.

Remote command:
`CONF:AUTO:FRAM ONCE`, see `CONFigure[:MS]:AUTO:FRAMe ONCE` on page 198

Automatic Trigger Offset
If activated, the trigger offset (for external and IF power triggers) are detected and automatically measured.

This function is **not** available in **MSRA** mode.

For details on the trigger offset refer to "Trigger Offset" on page 88.

Remote command:
`CONF:AUTO:TRIG ONCE`, see `CONFigure[:MS]:AUTO:TRIGger ONCE` on page 199

7 Analysis

General result analysis settings concerning the trace, markers, windows etc. can be configured via the "Result Configuration" dialog box, which is displayed when you do one of the following:

- In the "Overview", select the "Result Config" button.
- Press the MEAS CONFIG key, then select the "Result Config" softkey.

- Result Configuration....109
- Display Configuration....115
- Zoom Functions....116

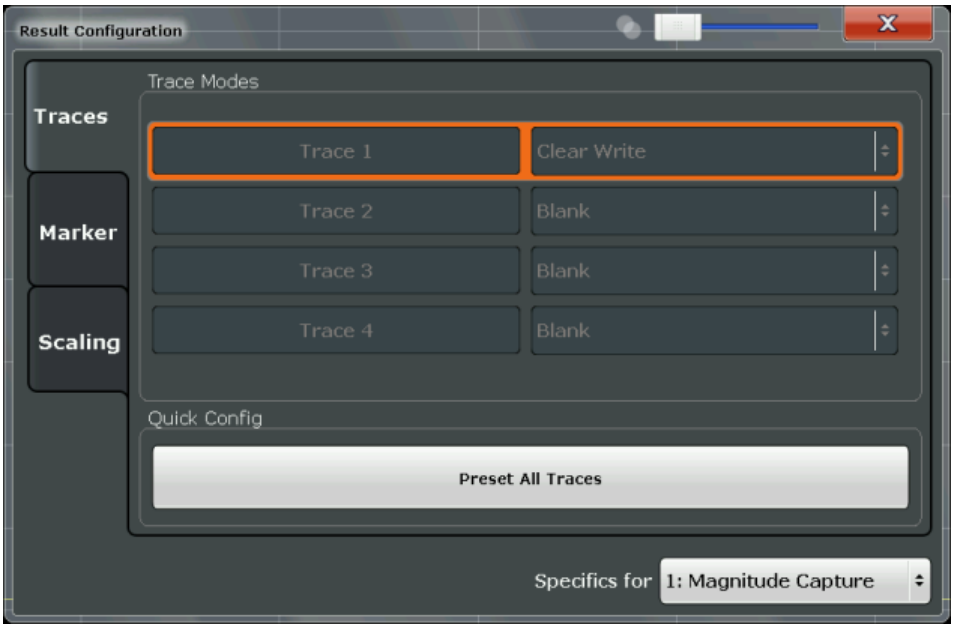
7.1 Result Configuration

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window (see "Specifics for" on page 62).

- Traces....109
- Markers....110
- Y-Scaling....114

7.1.1 Traces

The number of available traces depends on the selected window (see "Specifics for" on page 62). Only graphical evaluations have trace settings.



Trace 1/Trace 2/Trace 3/Trace 4.....110
Trace Mode.....110
Preset All Traces.....110
Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys).....110

Trace 1/Trace 2/Trace 3/Trace 4
Selects the corresponding trace for configuration. The currently selected trace is highlighted orange.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 207
Selected via numeric suffix of `TRACe<t>` commands

Trace Mode
Defines the update mode for subsequent traces.

The available trace modes depend on the selected result display. Not all evaluations support all trace modes.

"Clear Write"	Overwrite mode: the trace is overwritten by each sweep.
"Max Hold"	The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.
"Min Hold"	The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.
"Average"	The average is formed over several sweeps. The Statistic Count determines the number of averaging procedures.
"Blank"	Removes the selected trace from the display.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>:MODE` on page 207

Preset All Traces
Restores the active traces and trace modes defined by the default settings for the active result displays (see table 6-2).

Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)
Displays the "Traces" settings and focuses the "Mode" list for the selected trace.

Remote command:
`DISPlay[:WINDow<n>]:TRACe<t>[:STATe]` on page 207

7.1.2 Markers

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display. Up to 4 markers can be configured.

Markers are configured in the "Marker" dialog box which is displayed when you do one of the following:

- In the "Overview", select "Result Config", and switch to the vertical "Marker" tab.
- Press the MEAS CONFIG, MKR or MKR TO key, then select the "Marker Config" softkey.

- Individual Marker Settings....111
- General Marker Settings....112
- Marker Positioning Functions....113

7.1.2.1 Individual Marker Settings

In GSM evaluations, up to 4 markers can be activated in each diagram at any time.

Selected Marker....111
Marker State....112
X-value....112
Marker Type....112
Assigning the Marker to a Trace....112
All Markers Off....112

Selected Marker
Marker name. The marker which is currently selected for editing is highlighted orange.

Remote command:
Marker selected via suffix <m> in remote commands.

Marker State
Activates or deactivates the marker in the diagram.

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 210
CALCulate<n>:DELTamarker<m>[:STATe] on page 209

X-value
Defines the position of the marker on the x-axis (channel, slot, symbol, depending on evaluation).

Remote command:
CALCulate<n>:DELTamarker<m>:X on page 253
CALCulate<n>:MARKer<m>:X on page 254

Marker Type
Toggles the marker type.

The type for marker 1 is always "Normal", the type for delta marker 1 is always "Delta". These types cannot be changed.

Note: If normal marker 1 is the active marker, switching the "Mkr Type" activates an additional delta marker 1. For any other marker, switching the marker type does not activate an additional marker, it only switches the type of the selected marker.

"Normal" A normal marker indicates the absolute value at the defined position in the diagram.

"Delta" A delta marker defines the value of the marker relative to the specified reference marker (marker 1 by default).

Remote command:
CALCulate<n>:MARKer<m>[:STATe] on page 210
CALCulate<n>:DELTamarker<m>[:STATe] on page 209

Assigning the Marker to a Trace
The "Trace" setting assigns the selected marker to an active trace. The trace determines which value the marker shows at the marker position. If the marker was previously assigned to a different trace, the marker remains on the previous frequency or time, but indicates the value of the new trace.

If a trace is turned off, the assigned markers and marker functions are also deactivated.

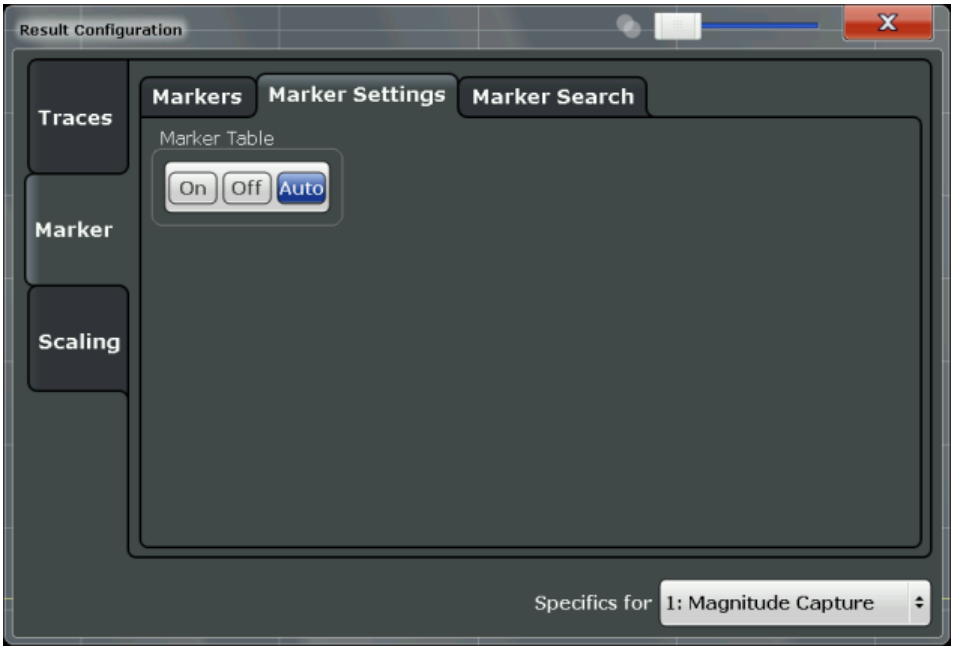
Remote command:
CALCulate<n>:MARKer<m>:TRACe on page 211

All Markers Off
Deactivates all markers in one step.

Remote command:
CALCulate<n>:MARKer<m>:AOFF on page 210

7.1.2.2 General Marker Settings

General marker settings are defined in the "Marker Config" tab of the "Marker" dialog box.



Marker Table Display
Defines how the marker information is displayed.

"On" Displays the marker information in a table in a separate area beneath the diagram.

"Off" Displays the marker information within the diagram area.

Remote command:
`DISPlay:MTABle` on page 211

7.1.2.3 Marker Positioning Functions

The following functions set the currently selected marker to the result of a peak search. These functions are available as softkeys in the "Marker To" menu, which is displayed when you press the MKR -> key.

Select Marker....113
Peak Search....114
Search Minimum....114
Max |Peak|....114

Select Marker
Selects the subsequent marker (marker 1/2/3/4 or delta marker) to be edited or to be used for a marker function. The currently selected marker number is highlighted.

Remote command:
Marker selected via suffix <m> in remote commands.

Peak Search
Sets the selected marker/delta marker to the maximum of the trace. If no marker is active, marker 1 is activated.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum[:PEAK]` on page 212
`CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]` on page 212

Search Minimum
Sets the selected marker/delta marker to the minimum of the trace. If no marker is active, marker 1 is activated.

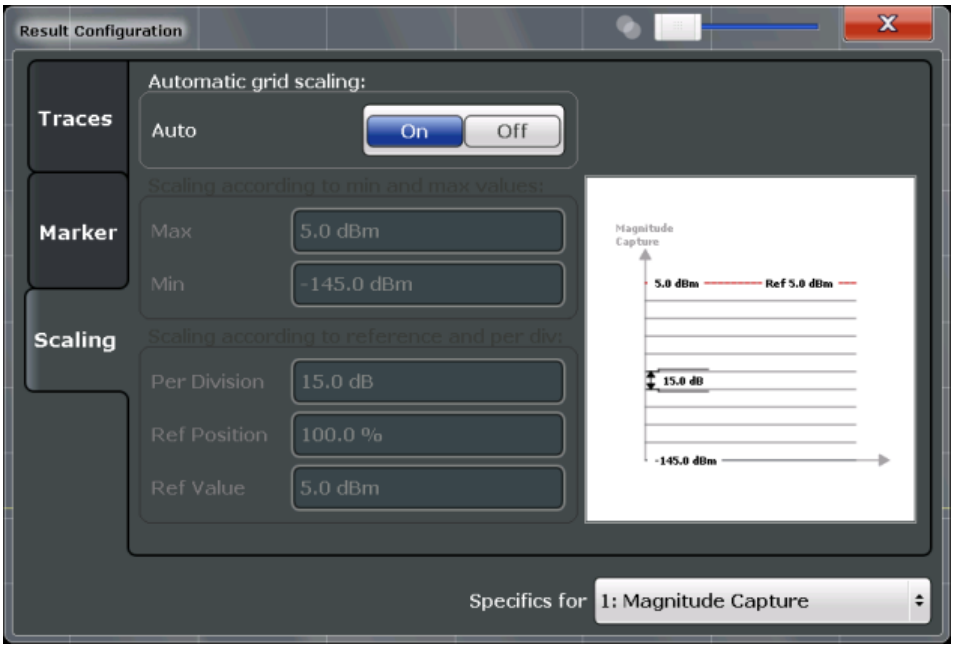
Remote command:
`CALCulate<n>:MARKer<m>:MINimum[:PEAK]` on page 212
`CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]` on page 212

Max |Peak|
Sets the active marker/delta marker to the largest absolute peak value (maximum or minimum) of the selected trace.

Remote command:
`CALCulate<n>:MARKer<m>:MAXimum:APEak` on page 212

7.1.3 Y-Scaling

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These settings are described here.



Automatic Grid Scaling....115
Absolute Scaling (Min/Max Values)....115
Relative Scaling (Reference/ per Division)....115

└ Per Division....115
└ Ref Position....115
└ Ref Value....115

Automatic Grid Scaling
The y-axis is scaled automatically according to the current measurement settings and results.

Remote command:
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO on page 213

Absolute Scaling (Min/Max Values)
Define the scaling using absolute minimum and maximum values.

Remote command:
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum on page 213
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum on page 213

Relative Scaling (Reference/ per Division)
Define the scaling relative to a reference value, with a specified value range per division.

Per Division ← Relative Scaling (Reference/ per Division)
Defines the value range to be displayed per division of the diagram (1/10 of total range).

Note: The value defined per division refers to the default display of 10 divisions on the y-axis. If fewer divisions are displayed (e.g. because the window is reduced in height), the range per division is increased in order to display the same result range in the smaller window. In this case, the per division value does not correspond to the actual display.

Remote command:
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision on page 169

Ref Position ← Relative Scaling (Reference/ per Division)
Defines the position of the reference value in percent of the total y-axis range.

Remote command:
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RPOSition on page 214

Ref Value ← Relative Scaling (Reference/ per Division)
Defines the reference value to be displayed at the specified reference position.

Remote command:
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RVALue on page 214

7.2 Display Configuration

The captured signal can be displayed using various evaluation methods. All evaluation methods available for the GSM application are displayed in the evaluation bar in SmartGrid mode when you do one of the following:

- Select the "SmartGrid" icon from the toolbar.
- Select the "Display Config" button in the "Overview".

- Press the MEAS key.
- Select the "Display Config" softkey in any GSM menu.

Up to 16 evaluation methods can be displayed simultaneously in separate windows. The GSM evaluation methods are described in chapter 4, "Measurement Results", on page 15.

For details on working with the SmartGrid see the R&S FSW Getting Started manual.

7.3 Zoom Functions

The zoom functions are only available from the toolbar.

Single Zoom....116
Multiple Zoom....116
Restore Original Display....116
Deactivating Zoom (Selection mode)....117

Single Zoom

A single zoom replaces the current diagram by a new diagram which displays an enlarged extract of the trace. This function can be used repetitively until the required details are visible.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:STATe` on page 218
`DISPlay[:WINDow<n>]:ZOOM:AREA` on page 217

Multiple Zoom

In multiple zoom mode, you can enlarge several different areas of the trace simultaneously. An overview window indicates the zoom areas in the original trace, while the zoomed trace areas are displayed in individual windows. The zoom area that corresponds to the individual zoom display is indicated in the lower right corner, between the scrollbars.

Remote command:
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe` on page 219
`DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA` on page 218

Restore Original Display

Restores the original display and closes all zoom windows.

Remote command:
DISPlay[:WINDow<n>]:ZOOM:STATe on page 218 (single zoom)
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe on page 219 (for each multiple zoom window)

Deactivating Zoom (Selection mode)

Deactivates zoom mode; tapping the screen no longer invokes a zoom, but selects an object.

Remote command:
DISPlay[:WINDow<n>]:ZOOM:STATe on page 218 (single zoom)
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe on page 219 (for each multiple zoom window)

8 I/Q Data Import and Export

Baseband signals mostly occur as so-called complex baseband signals, i.e. a signal representation that consists of two channels; the in phase (I) and the quadrature (Q) channel. Such signals are referred to as I/Q signals. I/Q signals are useful because the specific RF or IF frequencies are not needed. The complete modulation information and even distortion that originates from the RF, IF or baseband domains can be analyzed in the I/Q baseband.

Importing and exporting I/Q signals is useful for various applications:

- Generating and saving I/Q signals in an RF or baseband signal generator or in external software tools to analyze them with the R&S FSW later
- Capturing and saving I/Q signals with an RF or baseband signal analyzer to analyze them with the R&S FSW or an external software tool later

For example, you can capture I/Q data using the I/Q Analyzer application, if available, and then perform a GSM measurement on that data later using the R&S FSW GSM application.

As opposed to storing trace data, which may be averaged or restricted to peak values, I/Q data is stored as it was captured, without further processing. The data is stored as complex values in 32-bit floating-point format. Multi-channel data is not supported. The I/Q data is stored in a format with the file extension `.iq.tar`. For a detailed description see chapter A.2, "I/Q Data File Format (iq-tar)", on page 280.

- Import/Export Functions....118
- How to Export and Import I/Q Data....119

8.1 Import/Export Functions

The following import and export functions are available via softkeys in the "Save/Recall" menu which is displayed when you select the "Save" or "Open" icon in the toolbar.

For a description of the other functions in the "Save/Recall" menu see the R&S FSW User Manual.

Export....118
└ IQ Export....119
Import....119
└ IQ Import....119

Export
Opens a submenu to configure data export.

IQ Export ← Export
Opens a file selection dialog box to select an export file to which the IQ data will be stored. This function is only available in single sweep mode, and only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

Import
Provides functions to import data.

IQ Import ← Import
Opens a file selection dialog box to select an import file that contains IQ data. This function is only available in single sweep mode and only in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

Note that the I/Q data must have a specific format as described in chapter A.2, "I/Q Data File Format (iq-tar)", on page 280.

I/Q import is not available in MSRA mode.

For details see chapter 8, "I/Q Data Import and Export", on page 118.

Remote command:
`MMEMory:LOAD:IQ:STATe` on page 255

8.2 How to Export and Import I/Q Data

I/Q data can only be exported in applications that process I/Q data, such as the I/Q Analyzer or optional applications.

Capturing and exporting I/Q data

1. Press the PRESET key.
2. Press the MODE key and select the "IQ Analyzer" or any other application that supports I/Q data.
3. Configure the data acquisition.
4. Press the RUN SINGLE key to perform a single sweep measurement.
5. Select the "Save" icon in the toolbar.
6. Select the "I/Q Export" softkey.
7. In the file selection dialog box, select a storage location and enter a file name.
8. Select "Save".

   The captured data is stored to a file with the extension `.iq.tar`.

Importing I/Q data

1. Press the MODE key and select the "IQ Analyzer" or any other application that supports I/Q data.
2. If necessary, switch to single sweep mode by pressing the RUN SINGLE key.
3. Select the "Open" icon in the toolbar.
4. Select the "I/Q Import" softkey.
5. Select the storage location and the file name with the `.iq.tar` file extension.
6. Select "Open".

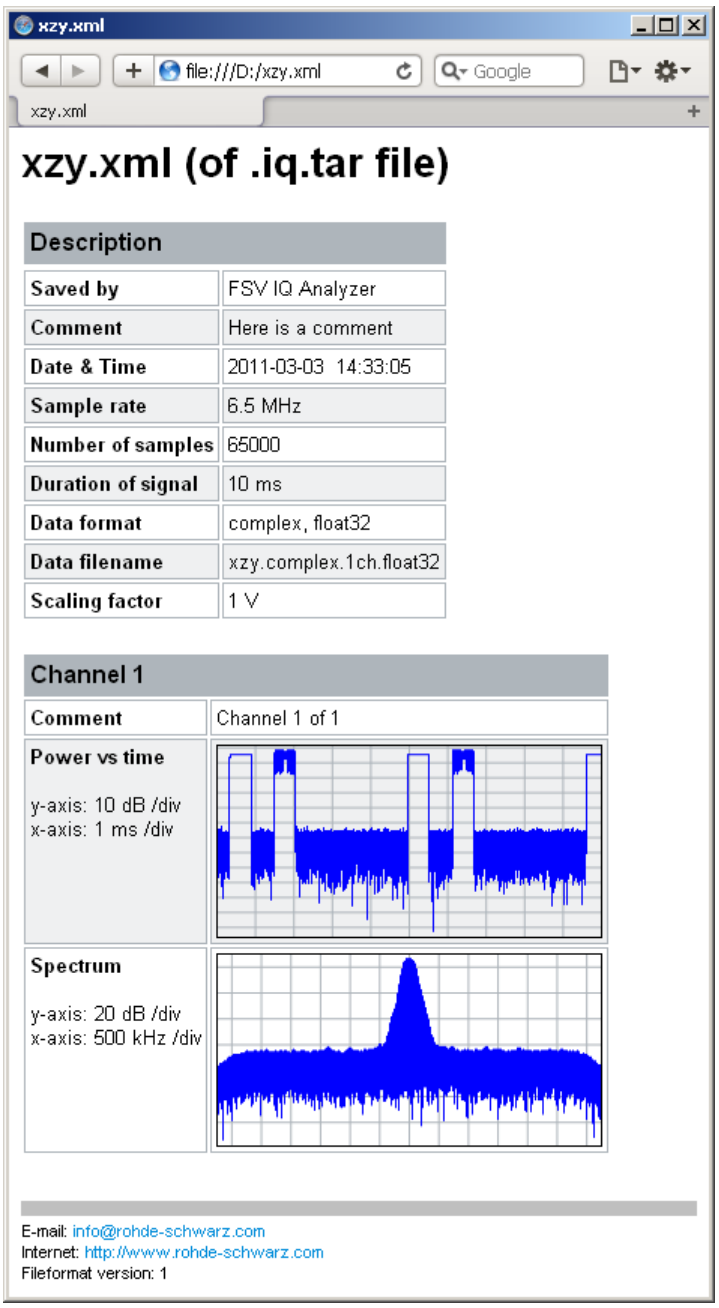
   The stored data is loaded from the file and displayed in the current application.

Previewing the I/Q data in a web browser

The `iq-tar` file format allows you to preview the I/Q data in a web browser.

1. Use an archive tool (e.g. WinZip® or PowerArchiver®) to unpack the `iq-tar` file into a folder.
2. Locate the folder using Windows Explorer.
3. Open your web browser.

4. Drag the I/Q parameter XML file, e.g. `example.xml`, into your web browser.



9 How to Perform Measurements in the GSM Application

The following step-by-step instructions demonstrate how to perform common GSM measurements with the R&S FSW GSM application.

- How to Perform a Basic Measurement on GSM Signals.....122
- How to Determine Modulation Accuracy Parameters for GSM Signals.....123
- How to Analyze the Power in GSM Signals.....124
- How to Analyze the Spectrum of GSM Signals.....126

9.1 How to Perform a Basic Measurement on GSM Signals

1. Press the MODE key on the front panel and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.

9. Select the "Measurement" button and define the special measurement settings for the Spectrum, Trigger to Sync and Power vs Time measurements.
   In particular, define the frequency list to be used to determine the modulation spectrum, and filters to be used for multicarrier measurements.
10. Select the "Display Config" button and select up to 16 displays that are of interest to you.
    Arrange them on the display to suit your preferences.
11. Exit the SmartGrid mode and select the "Overview" softkey to display the "Overview" again.
12. Select the "Result Config" button to configure settings for specific result displays.
    These settings can be configured individually for each window, so select the window first and then configure the settings.
    - Define the "Traces" to be displayed in the window.
      Optionally, configure the trace to display the average over a series of measurements. If necessary, increase the "Statistics Count" in the "Sweep Config" dialog box.
    - Configure markers and delta markers to determine deviations and offsets within the results, e.g. when comparing errors or peaks.
    - Adapt the diagram scaling to the displayed data.
13. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.

9.2 How to Determine Modulation Accuracy Parameters for GSM Signals

1. Press the MODE key on the front panel and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.

4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Display Config" button and activate one or more of the following result displays for modulation accuracy and error parameters (up to a total of 16 windows):
   - Modulation Accuracy
   - EVM
   - Magnitude Error
   - Phase Error

   Tip: Also activate the Magnitude Capture result display for a general overview of the measured data.
   Arrange them on the display to suit your preferences.
10. Exit the SmartGrid mode.
11. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.
12. Check the Magnitude Capture for irregular behavior, e.g. an unexpected rise or fall in power. If such an effect occurs, determine whether it occured in the current slot scope and current slot to measure (compare the green and blue bars beneath the trace). If necessary, zoom into the display to view it in greater detail.
13. If necessary, change the **slot scope** or **slot to measure** to display the slot of interest (e.g. using the softkeys in the "GSM" menu).

    Now you can analyze the Magnitude Error, Phase Error, or EVM for that slot.
14. Compare the current results of the EVM with those of previous measurements to find out if the error occurs only sporadically or repeatedly.

9.3 How to Analyze the Power in GSM Signals

1. Press the MODE key on the front panel and select the "GSM" application.

2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.
6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Measurement" button and define the special measurement settings for the Power vs Time measurement:
   - Define the PvT filter to be used (for selection criteria see chapter 5.7.2, "Power vs Time Filter", on page 44).
   - Define how the limit line defined by the standard is to be aligned to the measured slots, and whether the relative positioning of the TSCs is measured or derived from the position of the specified Slot to Measure only.
     For measurements strictly **according to standard**, use the default "Limit Line Time Alignment": "Slot to Measure".
     For **non-standard** signals or signals with conspicuous slot timing, use the "Per Slot" setting.
     (**Tip**: use the "Delta to Sync" result of the Power vs Slot measurement to verify the slot timing.)
10. Select the "Display Config" button and select one or more of the following displays for power results (up to a total of 16 windows):
    - PvT Full Burst (power **graph** of **all slots** (bursts) in the selected slot scope **over time**)

- Power vs Slot (**table** of power **per slot** in the current frame and over all frames)

Tip: Also display the Magnitude Capture for a general overview of the measured data. Arrange them on the display to suit your preferences.

11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.
    - To perform a single measurement, press the RUN SINGLE key.
    - To start a (new) continuous measurement, press the RUN CONT key.
13. Check the PvT Full Burst results to determine if the signal remains within the limits specified by the standard in all slots to measure.
14. If the "Limit Check" indicates "FAIL", zoom into the Power vs Time graph to determine the time at which the power exceeded the limit.
    Note: in measurements according to standard, the delta value will be identical for all slots in the scope due to the "Limit Line Time Alignment": "Slot to Measure" setting (see step 9).
15. Check the irregular slot in more detail in the Magnitude Capture (compare the green and blue bars beneath the trace). If necessary, zoom into the display to view it in greater detail.

9.4 How to Analyze the Spectrum of GSM Signals

1. Press the MODE key on the front panel and select the "GSM" application.
2. Select the "Overview" softkey to display the "Overview" for a GSM measurement.
3. Select the "Signal Description" button and configure the expected signal by defining the used device and slot characteristics as well as the modulation:
   - Define the expected burst type and modulation for each active slot.
   - Define the training sequences (or syncs) with which each slot will be compared to synchronize the measured data with the expected data.
   - For **AQPSK** modulated signals, define a TSC for each subchannel and each active slot.
   - For **access bursts**, also define a "Timing Advance", i.e. the position of the burst within the slot.
   - For signals from base stations capable of using **multiple carriers**, define additional settings on the "Multicarrier" tab.
4. Select the "Input/Frontend" button and then the "Frequency" tab to define the input signal's frequency band and center frequency.
5. Select the "Amplitude" tab in the "Input/Frontend" dialog box to define the correct power class for the base station or mobile device.

6. Optionally, select the "Trigger" button and define a trigger for data acquisition, for example an external trigger to start capturing data only when a useful signal is transmitted. For external triggers, do not forget to set the correct "Trigger Offset" to the beginning of the GSM frame.
7. Optionally, to perform statistical evaluation over several measurements, switch to the "Sweep" tab in the "Data Acquisition" dialog box and define a "Statistics Count".
8. Select the "Demodulation" button to determine how bursts are detected and demodulated.
9. Select the "Measurement" button and define the special measurement settings for the Spectrum measurements:
   - For **multicarrier** base stations, define which carriers are measured:
     – the left-most carrier only ("Enable Left Limit" = ON)
     – the right-most carrier only ("Enable Right Limit" = ON)
     – all carriers ("Enable Left Limit" = ON, "Enable Right Limit" = ON)
   - Select the type of resolution filter to be used.
     For measurements strictly according to standard, use the "Normal (3dB)" filter.
   - Select the frequency list to be used to determine the modulation spectrum.
     For a quick overview, select a sparse list; for a conformance test, use the list specified by the standard
     As a rule, use the narrow list to test mobile devices, use the wide list for base station tests.
   - Select the reference power to be used to determine the relative limit values for the transient spectrum.
     For measurements strictly according to standard, use the "RMS" setting.
10. Select the "Display Config" button and select one or more of the following displays for spectrum results (up to a total of 16 windows):
    - "Modulation Spectrum Graph" on page 20
    - "Modulation Spectrum Table" on page 22
    - "Transient Spectrum Graph" on page 27
    - "Transient Spectrum Table" on page 28

    Tips:
    - Also display the Magnitude Capture for a general overview of the measured data.
    - Use the **graph** displays for a general overview of the currently measured spectrum; the **tables** provide detailed numeric values, and an accurate conformance check of the DUT to the GSM standard.
    - The **modulation spectrum** shows the spectrum for a portion of a burst in a single slot (see "Modulation Spectrum Graph" on page 20); the **transient spectrum** shows the spectrum for all slots in the slot scope, including the rising and falling edges of the bursts.

    Arrange the windows on the display to suit your preferences.
11. Exit the SmartGrid mode.
12. Start a new sweep with the defined settings.

- To perform a single measurement, press the RUN SINGLE key.
- To start a (new) continuous measurement, press the RUN CONT key.

13. Check the result of the limit check in the graph. If it indicates "FAIL", refer to the numeric results in the table display for more precise information on which frequency exceeds the limit (indicated by a negative "Δ to Limit" value and red characters).

10 Optimizing and Troubleshooting the Measurement

If the results of a GSM measurement do not meet your expectations, try the following recommendations to optimize the measurement.

- Improving Performance....129
- Improving EVM Accuracy....129
- Optimizing Limit Checks....130
- Error Messages....131

10.1 Improving Performance

If the GSM measurement seems to take a long time, try the following tips.

Using external triggers to mark the frame start

The R&S FSW GSM application needs the frame start as a time reference. It either searches for a frame start after every I/Q data acquisition, or relies on a trigger event that marks the frame start. An external trigger or a power trigger that mark the frame start can speed up measurements. See also chapter 5.5, "Trigger settings", on page 39.

In MSRA mode, trigger events are not considered when determining the frame start in a GSM measurement, as the trigger is defined by the MSRA Master for all applications simultaneously and most likely does not coincede with the frame start for the GSM signal.

Avoiding unnecessary high sample rates

According to the GSM standard, modulation spectrum results must be performed at frequencies up to 6 MHz from the carrier in some cases. When the frequency list to be used is set to 6 MHz in the "Measurement" settings (see "Modulation Spectrum Table: Frequency List" on page 104), the R&S FSW GSM application uses a sample rate of 19.5 MHz, as opposed to the usual 6.5 MHz sample rate. The higher sample rate extends the required measurement time. Only use the 6 MHz frequency list setting if you actually require "Modulation Spectrum" results according to standard.

10.2 Improving EVM Accuracy

If the EVM results show unexpected power levels, check the following issues.

Extending the data basis

Sporadic distortions in the EVM can be eliminated by evaluating several measurements and determining the average over all traces. Increase the Statistic Count in the "Sweep" settings to obtain sufficiently stable results.

Excluding results from adjacent channels

For signals from base stations capable of using **multiple carriers**, configure the DUT as such in the signal description (see chapter 6.3.3, "Multicarrier Settings", on page 69). In this case, an additional multicarrier (PvT) filter suppresses power from adjacent channels. This filter is also taken into account during the generation of the ideal (reference) signal, otherwise there would be an increase in EVM because the measured signal has a smaller bandwidth compared to the reference signal. Define which PvT filter to use, depending on whether the channel to be measured has a reduced or equal power compared to its adjacent channels (see "Multicarrier PvT Filter" on page 102).

For single carrier measurements, make sure the "Multicarrier BTS" setting is "Off" (see "Multicarrier BTS" on page 69) so the correct PvT filter is used for the power measurement.

10.3 Optimizing Limit Checks

If the limit checks fail unexpectedly, check the following issues.

Excluding results from adjacent channels

In limit checks for multicarrier **spectrum measurements**, the frequencies from adjacent carriers in the signal may distort the results of the limit check for a single carrier. If you only want to check the frequencies from a single carrier in a **multicarrier signal**, disable the limit check for frequencies to the left or right of the carrier frequency of interest (see "Enable Left Limit/ Enable Right Limit" on page 103). This allows you to measure the spectrum of the left or right-most channel while ignoring the side where adjacent channels are located.

Make sure you select the correct Slot to Measure for **Modulation Spectrum** results (see chapter 6.7.1, "Slot Scope", on page 95).

Calculating limit lines according to the used DUT

For **multicarrier** measurements, ensure that the **DUT** is configured correctly (see chapter 6.3.1, "Frame and DUT Settings", on page 63). The number of active carriers and the specified BTS class affect the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement.

Aligning the limit line correctly

The limit line defined by the standard must be aligned to the measured slots. The alignment can either be determined individually for each slot, or the entire line is aligned according to the Slot to Measure (see "Limit Line Time Alignment" on page 102).

The **standard** requires that the entire line be aligned according to the Slot to Measure. However, in this case the "Delta to Sync" value will be identical for all slots in the scope (see table 4-6).

Note that the R&S FSW GSM application assumes that all slots have equal length. If they do not, disable this setting in the "Frame" settings (see "Equal Timeslot Length" on page 64) so the limit line is aligned to the slots correctly.

For **non-standard** signals or if you require more precise delta values, use the "Time Alignment": "Per Slot" setting.

10.4 Error Messages

The following error messages may be displayed in the status bar of the R&S FSW GSM application. Check these descriptions for possible error causes and solutions.

Burst not found.....131
Sync not found.....131

Burst not found

Possible causes	Possible solutions
Training sequence (TSC) or sync is not defined correctly.	Check the TSC/sync definition in "Slot" settings (see "Training Sequence TSC / Sync" on page 68)
Slot is not in defined slot scope	Include the slot in the slots to measure (see chapter 6.7.1, "Slot Scope", on page 95)

Sync not found

Possible causes	Possible solutions
Training sequence (TSC) or sync is not defined correctly.	Check the TSC/sync definition in "Slot" settings (see "Training Sequence TSC / Sync" on page 68)
No or incorrect position of access burst in slot defined.	Define the correct "Timing Advance" for the slots containing an access burst (see "Timing Advance (Access Burst only)" on page 68).
The trigger event does not correspond to the start of the "active part" in slot 0.	Correct the trigger offset (for an external trigger, see "Trigger Offset" on page 88)
The DUT interchanged the I and Q parts of the signal.	Swap the I and Q values after data acquisition in the R&S FSW GSM application to reverse this effect (see "Swap I/Q" on page 76).

11 Remote Commands to Perform GSM Measurements

The following commands are required to perform measurements in the GSM application in a remote environment. It is assumed that the R&S FSW has already been set up for remote operation in a network as described in the R&S FSW User Manual.

Note that basic tasks that are also performed in the base unit in the same way are not described here. For a description of such tasks, see the R&S FSW User Manual.

In particular, this includes:

- Managing Settings and Results, i.e. storing and loading settings and result data
- Basic instrument configuration, e.g. checking the system configuration, customizing the screen layout, or configuring networks and remote operation
- Using the common status registers

The following topics specific to the GSM application are described here:

- Introduction....132
- Common Suffixes....137
- Activating GSM Measurements....137
- Configuring and Performing GSM Measurements....142
- Analyzing GSM Measurements....200
- Retrieving Results....219
- Importing and Exporting I/Q Data and Results....255
- Status Reporting System....256
- Deprecated Commands (Commands for Compatibility)....262
- Programming Examples....269

11.1 Introduction

Commands are program messages that a controller (e.g. a PC) sends to the instrument or software. They operate its functions ('setting commands' or 'events') and request information ('query commands'). Some commands can only be used in one way, others work in two ways (setting and query). If not indicated otherwise, the commands can be used for settings and queries.

The syntax of a SCPI command consists of a header and, in most cases, one or more parameters. To use a command as a query, you have to append a question mark after the last header element, even if the command contains a parameter.

A header contains one or more keywords, separated by a colon. Header and parameters are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). If there is more than one parameter for a command, these are separated by a comma from one another.

Only the most important characteristics that you need to know when working with SCPI commands are described here. For a more complete description, refer to the User Manual of the R&S FSW.

Remote command examples

Note that some remote command examples mentioned in this general introduction may not be supported by this particular application.

11.1.1 Conventions used in Descriptions

Note the following conventions used in the remote command descriptions:

- **Command usage**
  If not specified otherwise, commands can be used both for setting and for querying parameters.
  If a command can be used for setting or querying only, or if it initiates an event, the usage is stated explicitely.
- **Parameter usage**
  If not specified otherwise, a parameter can be used to set a value and it is the result of a query.
  Parameters required only for setting are indicated as **Setting parameters**.
  Parameters required only to refine a query are indicated as **Query parameters**.
  Parameters that are only returned as the result of a query are indicated as **Return values**.
- **Conformity**
  Commands that are taken from the SCPI standard are indicated as **SCPI confirmed**. All commands used by the R&S FSW follow the SCPI syntax rules.
- **Asynchronous commands**
  A command which does not automatically finish executing before the next command starts executing (overlapping command) is indicated as an **Asynchronous command**.
- **Reset values (*RST)**
  Default parameter values that are used directly after resetting the instrument (`*RST` command) are indicated as ***RST** values, if available.
- **Manual operation**
  If the result of a remote command can also be achieved in manual operation, a link to the description is inserted.

11.1.2 Long and Short Form

The keywords have a long and a short form. You can use either the long or the short form, but no other abbreviations of the keywords.

The short form is emphasized in upper case letters. Note however, that this emphasis only serves the purpose to distinguish the short from the long form in the manual. For the instrument, the case does not matter.

Example:

`SENSe:FREQuency:CENTer` is the same as `SENS:FREQ:CENT`.

11.1.3 Numeric Suffixes

Some keywords have a numeric suffix if the command can be applied to multiple instances of an object. In that case, the suffix selects a particular instance (e.g. a measurement window).

Numeric suffixes are indicated by angular brackets (<n>) next to the keyword.

If you don't quote a suffix for keywords that support one, a 1 is assumed.

Example:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe` enables the zoom in a particular measurement window, selected by the suffix at `WINDow`.

`DISPlay:WINDow4:ZOOM:STATe ON` refers to window 4.

11.1.4 Optional Keywords

Some keywords are optional and are only part of the syntax because of SCPI compliance. You can include them in the header or not.

Note that if an optional keyword has a numeric suffix and you need to use the suffix, you have to include the optional keyword. Otherwise, the suffix of the missing keyword is assumed to be the value 1.

Optional keywords are emphasized with square brackets.

Example:

Without a numeric suffix in the optional keyword:

`[SENSe:]FREQuency:CENTer` is the same as `FREQuency:CENTer`

With a numeric suffix in the optional keyword:

`DISPlay[:WINDow<1...4>]:ZOOM:STATe`

`DISPlay:ZOOM:STATe ON` enables the zoom in window 1 (no suffix).

`DISPlay:WINDow4:ZOOM:STATe ON` enables the zoom in window 4.

11.1.5 Alternative Keywords

A vertical stroke indicates alternatives for a specific keyword. You can use both keywords to the same effect.

Example:

`[SENSe:]BANDwidth|BWIDth[:RESolution]`

In the short form without optional keywords, `BAND 1MHZ` would have the same effect as `BWID 1MHZ`.

11.1.6 SCPI Parameters

Many commands feature one or more parameters.

If a command supports more than one parameter, these are separated by a comma.

Example:

```
LAYout:ADD:WINDow Spectrum,LEFT,MTABle
```

Parameters may have different forms of values.

- Numeric Values....135
- Boolean....136
- Character Data....136
- Character Strings....137
- Block Data....137

11.1.6.1 Numeric Values

Numeric values can be entered in any form, i.e. with sign, decimal point or exponent. In case of physical quantities, you can also add the unit. If the unit is missing, the command uses the basic unit.

Example:

with unit: `SENSe:FREQuency:CENTer 1GHZ`

without unit: `SENSe:FREQuency:CENTer 1E9` would also set a frequency of 1 GHz.

Values exceeding the resolution of the instrument are rounded up or down.

If the number you have entered is not supported (e.g. in case of discrete steps), the command returns an error.

Instead of a number, you can also set numeric values with a text parameter in special cases.

- MIN/MAX
  Defines the minimum or maximum numeric value that is supported.
- DEF
  Defines the default value.
- UP/DOWN
  Increases or decreases the numeric value by one step. The step size depends on the setting. In some cases you can customize the step size with a corresponding command.

Querying numeric values

When you query numeric values, the system returns a number. In case of physical quantities, it applies the basic unit (e.g. Hz in case of frequencies). The number of digits after the decimal point depends on the type of numeric value.

Example:

Setting: `SENSe:FREQuency:CENTer 1GHZ`

Query: `SENSe:FREQuency:CENTer?` would return `1E9`

In some cases, numeric values may be returned as text.

- INF/NINF
  Infinity or negative infinity. Represents the numeric values 9.9E37 or -9.9E37.
- NAN
  Not a number. Represents the numeric value 9.91E37. NAN is returned in case of errors.

11.1.6.2 Boolean

Boolean parameters represent two states. The "ON" state (logically true) is represented by "ON" or a numeric value 1. The "OFF" state (logically untrue) is represented by "OFF" or the numeric value 0.

Querying boolean parameters

When you query boolean parameters, the system returns either the value 1 ("ON") or the value 0 ("OFF").

Example:

Setting: `DISPlay:WINDow:ZOOM:STATe ON`

Query: `DISPlay:WINDow:ZOOM:STATe?` would return `1`

11.1.6.3 Character Data

Character data follows the syntactic rules of keywords. You can enter text using a short or a long form. For more information see chapter 11.1.2, "Long and Short Form", on page 133.

Querying text parameters

When you query text parameters, the system returns its short form.

Example:

Setting: `SENSe:BANDwidth:RESolution:TYPE NORMal`

Query: `SENSe:BANDwidth:RESolution:TYPE?` would return `NORM`

11.1.6.4 Character Strings

Strings are alphanumeric characters. They have to be in straight quotation marks. You can use a single quotation mark (') or a double quotation mark (").

Example:

```
INSTRument:DELete 'Spectrum'
```

11.1.6.5 Block Data

Block data is a format which is suitable for the transmission of large amounts of data.

The ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all end or other control signs are ignored until all bytes are transmitted. #0 specifies a data block of indefinite length. The use of the indefinite format requires a NL^END message to terminate the data block. This format is useful when the length of the transmission is not known or if speed or other considerations prevent segmentation of the data into blocks of definite length.

11.2 Common Suffixes

In the GSM application, the following common suffixes are used in remote commands:

Suffix	Value range	Description
<m>	1..4	Marker
<n>	1..16	Window
<s>	0..7	Slot
<t>	1..4	Trace

11.3 Activating GSM Measurements

GSM measurements require a special application on the R&S FSW. A measurement is started immediately with the default settings.

INSTrument:CREate:DUPLicate....138
INSTrument:CREate[:NEW]....138
INSTrument:CREate:REPLace....138
INSTrument:DELete....139
INSTrument:LIST?....139
INSTrument:REName....140

INSTrument[:SELect]....141
SYSTem:PRESet:CHANnel[:EXECute]....141
SYSTem:SEQuencer....141

INSTrument:CREate:DUPLicate

This command duplicates the currently selected measurement channel, i.e starts a new measurement channel of the same type and with the identical measurement settings. The name of the new channel is the same as the copied channel, extended by a consecutive number (e.g. "Spectrum" -> "Spectrum 2").

The channel to be duplicated must be selected first using the `INST:SEL` command.

This command is not available if the MSRA Master channel is selected.

Example:
```
INST:SEL 'Spectrum'
INST:CRE:DUPL
```
Duplicates the channel named 'Spectrum' and creates a new measurement channel named 'Spectrum 2'.

Usage: Event

INSTrument:CREate[:NEW] <ChannelType>, <ChannelName>

This command adds an additional measurement channel. The number of measurement channels you can configure at the same time depends on available memory.

Parameters:

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 11-1.

<ChannelName> String containing the name of the channel. The channel name is displayed as the tab label for the measurement channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 11-1).

Example:
```
INST:CRE SAN, 'Spectrum 2'
```
Adds an additional spectrum display named "Spectrum 2".

INSTrument:CREate:REPLace <ChannelName1>,<ChannelType>,<ChannelName2>

This command replaces a measurement channel with another one.

Parameters:

<ChannelName1> String containing the name of the measurement channel you want to replace.

<ChannelType> Channel type of the new channel.
For a list of available channel types see table 11-1.

<ChannelName2> String containing the name of the new channel.
Note: If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel (see table 11-1).

Example: `INST:CRE:REPL 'Spectrum2',IQ,'IQAnalyzer'`
Replaces the channel named 'Spectrum2' by a new measurement channel of type 'IQ Analyzer' named 'IQAnalyzer'.

INSTrument:DELete <ChannelName>

This command deletes a measurement channel. If you delete the last measurement channel, the default "Spectrum" channel is activated.

Parameters:
<ChannelName> String containing the name of the channel you want to delete.
A measurement channel must exist in order to be able delete it.

Example: `INST:DEL 'Spectrum4'`
Deletes the spectrum channel with the name 'Spectrum4'.

INSTrument:LIST?

This command queries all active measurement channels. This is useful in order to obtain the names of the existing measurement channels, which are required in order to replace or delete the channels.

Return values:
<ChannelType>, <ChannelName> For each channel, the command returns the channel type and channel name (see table 11-1).
Tip: to change the channel name, use the `INSTrument:REName` command.

Example: `INST:LIST?`
Result for 3 measurement channels:
`'ADEM','Analog Demod','IQ','IQ Analyzer','SANALYZER','Spectrum'`

Usage: Query only

Table 11-1: Available measurement channel types and default channel names

Application	<ChannelType> Parameter	Default Channel Name*)
Spectrum	SANALYZER	Spectrum
I/Q Analyzer	IQ	IQ Analyzer
Pulse (R&S FSW-K6)	PULSE	Pulse
Analog Demodulation (R&S FSW-K7)	ADEM	Analog Demod
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

Application	<ChannelType> Parameter	Default Channel Name*)
GSM (R&S FSW-K10)	GSM	GSM
Multi-Carrier Group Delay (R&S FSW-K17)	MCGD	MC Group Delay
Noise (R&S FSW-K30)	NOISE	Noise
Phase Noise (R&S FSW-K40)	PNOISE	Phase Noise
VSA (R&S FSW-K70)	DDEM	VSA
3GPP FDD BTS (R&S FSW-K72)	BWCD	3G FDD BTS
3GPP FDD UE (R&S FSW-K73)	MWCD	3G FDD UE
TD-SCDMA BTS (R&S FSW-K76)	BTDS	TD-SCDMA BTS
TD-SCDMA UE (R&S FSW-K77)	MTDS	TD-SCDMA UE
cdma2000 BTS (R&S FSW-K82)	BC2K	CDMA2000 BTS
cdma2000 MS (R&S FSW-K83)	MC2K	CDMA2000 MS
1xEV-DO BTS (R&S FSW-K84)	BDO	1xEV-DO BTS
1xEV-DO MS (R&S FSW-K85)	MDO	1xEV-DO MS
WLAN (R&S FSW-K91)	WLAN	WLAN
LTE (R&S FSW-K10x)	LTE	LTE
Note: the default channel name is also listed in the table. If the specified name for a new channel already exists, the default name, extended by a sequential number, is used for the new channel.		

INSTrument:RENAme <ChannelName1>, <ChannelName2>

This command renames a measurement channel.

Parameters:

<ChannelName1> String containing the name of the channel you want to rename.

<ChannelName2> String containing the new channel name.
Note that you can not assign an existing channel name to a new channel; this will cause an error.

Example: `INST:REN 'Spectrum2','Spectrum3'`
Renames the channel with the name 'Spectrum2' to 'Spectrum3'.

INSTrument[:SELect] <ChannelType>

This command activates a new measurement channel with the defined channel type, or selects an existing measurement channel with the specified name.

See also `INSTrument:CREate[:NEW]` on page 138.

For a list of available channel types see table 11-1.

Parameters:

<ChannelType> **GSM**
GSM application, R&S FSW–K10

SYSTem:PRESet:CHANnel[:EXECute]

This command restores the default instrument settings in the current channel.

Use `INST:SEL` to select the channel.

Example: `INST 'Spectrum2'`
Selects the channel for "Spectrum2".
`SYST:PRES:CHAN:EXEC`
Restores the factory default settings to the "Spectrum2" channel.

Usage: Event

Manual operation: See "Preset Channel" on page 62

SYSTem:SEQuencer <State>

This command turns the Sequencer on and off. The Sequencer must be active before any other Sequencer commands (`INIT:SEQ...`) are executed, otherwise an error will occur.

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
The Sequencer is activated and a sequential measurement is started immediately.

OFF | 0
The Sequencer is deactivated. Any running sequential measurements are stopped. Further Sequencer commands (`INIT:SEQ...`) are not available.

*RST: 0

Example:

```
SYST:SEQ ON
```
Activates the Sequencer.
```
INIT:SEQ:MODE SING
```
Sets single Sequencer mode so each active measurement will be performed once.
```
INIT:SEQ:IMM
```
Starts the sequential measurements.
```
SYST:SEQ OFF
```

11.4 Configuring and Performing GSM Measurements

The following commands are required to configure a GSM measurement on an R&S FSW in a remote environment.

- Signal Description....142
- Input/Output Settings....155
- Frontend Configuration....166
- Triggering Measurements....173
- Data Acquisition....180
- Demodulation....187
- Measurement....192
- Adjusting Settings Automatically....198

11.4.1 Signal Description

The signal description provides information on the expected input signal, which optimizes frame detection and measurement.

- Frame....142
- Slot....147
- Multicarrier....154

11.4.1.1 Frame

Frame settings determine the frame configuration used by the device under test.

CONFigure[:MS]:DEVice:TYPE....142
CONFigure[:MS]:NETWork:FREQuency:BAND....143
CONFigure[:MS]:NETWork[:TYPE]....144
CONFigure[:MS]:POWer:CLASs....145
CONFigure[:MS]:CHANnel:FRAMe:EQUal....146

CONFigure[:MS]:DEVice:TYPE <Value>

This command specifies the type of device to be measured.

Parameters for setting and query:

<Value> BTSNormal | BTSMicro | BTSPico | MSNormal | MSSMall

BTSNormal
BTS, TRX power class Normal

BTSMicro
BTS, TRX power class Micro

BTSPico
BTS, TRX power class Pico

MSNormal
MS, normal type

MSSMall
MS, small type

*RST: BTSNormal

Example: `CONF:DEV:TYPE BTSNormal`

Manual operation: See "Device Type" on page 63

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:NETWork:FREQuency:BAND <Value>

This command works in conjunction with the`CONFigure[:MS]:NETWork[:TYPE]` command to specify the frequency band of the signal to be measured. The command is not in-line with the manual operation so the SCPI remote control command remains compatible with the R&S FS-K5.

Parameters for setting and query:

<Value> 380 | 410 | 450 | 480 | 710 | 750 | 810 | 850 | 900 | 1800 | 1900

380
380 MHz band – valid for TGSM

410
410 MHz band – valid for TGSM

450
450 MHz band – valid for GSM

480
480 MHz band – valid for GSM

710
710 MHz band – valid for GSM

750
750 MHz band – valid for GSM

810
810 MHz band – valid for TGSM

850
850 MHz band – valid for GSM

900
900 MHz band – valid for PGSM, EGSM, RGSM and TGSM

1800
1800 MHz band – valid for DCS

1900
1900 MHz band – valid for PCS

*RST: 900

Example: `CONF:NETW:FREQ 380`

Manual operation: See "Frequency Band" on page 64

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:NETWork[:TYPE] <Value>

This command works in conjunction with the `CONFigure[:MS]:NETWork:FREQuency:BAND` on page 143 command to specify the frequency band of the signal to be measured. The command is not in-line with the manual operation so the SCPI remote control command remains compatible with the R&S FS-K5.

Parameters for setting and query:

<Value> PGSM | EGSM | DCS | PCS | TGSM | RGSM | GSM

PGSM
Primary GSM

EGSM
Extended GSM

DCS
DCS

PCS
PCS

TGSM
T-GSM

RGSM
Railway GSM

GSM
GSM

*RST: EGSM

Example: `CONF:NETW PGSM`

Manual operation: See "Frequency Band" on page 64

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:POWer:CLASs <Value>

This command the power class of the device under test.

Parameters for setting and query:

<Value> 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | E1 | E2 | E3 | M1 | M2 | M3 | P1

1
MS and BTS power class 1

2
MS and BTS power class 2

3
MS and BTS power class 3

4
MS and BTS power class 4

5
MS and BTS power class 5

6
BTS power class 6

7
BTS power class 7

8
BTS power class 8

E1
MS power class E1

E2
MS power class E2

E3
MS power class E3

M1
BTS power class M1 (Micro)

M2
BTS power class M2 (Micro)

M3
BTS power class M3 (Micro)

P1
BTS power class P1 (Pico)

*RST: 2

Example: `CONF:POW:CLAS 1`

Manual operation: See "Power Class" on page 64

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:FRAMe:EQUal <State>

If activated, all slots of a frame have the same length (8 x 156.26 normal symbol periods).

If deactivated, slots number 0 and 4 of a frame have a longer duration, all other a shorter duration compared to the "equal slot length" (157, 156, 156, 156, 157, 156, 156, 156 normal symbol periods).

See 3GPP TS 51.0213GPP TS 51.021 and 3GPP TS 45.0103GPP TS 45.010 chapter "6.7 Timeslot length" for further details.

This parameter is used to adjust the time for the "Power vs Time" masks of all slots. The "Slot to measure" is used as the time reference for the entire frame.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

*RST: ON

Example: `CONF:CHAN:FRAM:EQU OFF`

Manual operation: See "Equal Timeslot Length" on page 64

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

11.4.1.2 Slot

The R&S FSW GSM application is slot-based. Thus, information on the expected slots of the input signal are required. The following commands are required to provide this information.

CONFigure[:MS]:CHANnel:SLOT<Number>:FILTer....147
CONFigure[:MS]:CHANnel:SLOT<Number>[:STATe]....148
CONFigure[:MS]:CHANnel:SLOT<Number>:MTYPe....148
CONFigure[:MS]:CHANnel:SLOT<s>:SCPir....149
CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER....150
CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC....150
CONFigure[:MS]:CHANnel:SLOT<Number>:TADVance....151
CONFigure[:MS]:CHANnel:SLOT<s>:TSC....151
CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER....152
CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE....153

CONFigure[:MS]:CHANnel:SLOT<Number>:FILTer <Type>

This command specifies the pulse shape of the ideal modulator.

Suffix:

<Number> <0..7>
the slot to configure

Parameters for setting and query:

<Type> GMSK | LINearised | NARRow | WIDE

GMSK
GMSK Pulse

LINearised
Linearised GMSK Pulse

NARRow
Narrow Pulse

WIDE
Wide Pulse

*RST: GMSK

Example: `CONF:CHAN:SLOT:FILT GMSK`

Manual operation: See "Filter" on page 67

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:SLOT<Number>[:STATe] <State>

This command activates this slot (this means that e.g. this slot is not considered as inactive in the PvT evaluation).

Suffix:

<Number> <0..7>
Select the slot to configure.

Parameters for setting and query:

<State> ON | OFF

Example: `CONF:CHAN:SLOT ON`

Manual operation: See "Slot State (On/Off)" on page 67

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:SLOT<Number>:MTYPe <Modulation>

This command specifies the modulation type.

Suffix:

<Number> <0..7>
the slot to configure

Parameters for setting and query:

<Modulation>

GMSK
GMSK, Gaussian Minimum Shift Keying, 1 bit/symbol.

QPSK
QPSK, Quadrature Phase Shift keying, 2 bits/symbol.

PSK8
8PSK (EDGE), Phase Shift Keying, 3 bits/symbol.

QAM16
16QAM, 16-ary Quadrature Amplitude Modulation, 4 bits/symbol.

QAM32
32QAM, 16-ary Quadrature Amplitude Modulation, 5 bits/symbol.

*RST: GMSK

Example:
```
CONF:CHAN:SLOT0:MTYP GMSK
```

Manual operation: See "Modulation" on page 67

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:SLOT<s>:SCPir <Value>

This command specifies the Subchannel Power Imbalance Ratio (SCPIR) of the specified slot.

Notes:

This command is only available for AQPSK modulation.

Suffix:

<s> <0..7>
Number of slot to configure

Parameters for setting and query:

<Value> numeric value

Subchannel Power Imbalance Ratio (SCPIR) in dB

Range: -15 to 15
*RST: 0
Default unit: NONE

Example:
// Subchannel Power Imbalance Ratio (SCPIR) = 4 dB
```
CONFigure:MS:CHANnel:SLOT0:SCPir 4
```

Manual operation: See "SCPIR" on page 67

For a detailed example see chapter 11.10.2, "Programming Example: Measuring an AQPSK Signal", on page 273.

CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER <Value>

This command sets the bits of the user definable TSC. The number of bits must be 26. `CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC:USER` must be set first.

This command is only available for AQPSK modulation.

Suffix:

<s> <0..7>
Number of slot to configure

<ch> <1|2>
Subchannel number

Parameters for setting and query:

<Value> string
String containing the 26 user-defined bits

Example: // Subchannel 1: User TSC
```
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC USER
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?
```
// -> USER

Manual operation: See "User TSC / User Sync " on page 68

For a detailed example see chapter 11.10.2, "Programming Example: Measuring an AQPSK Signal", on page 273.

CONFigure[:MS]:CHANnel:SLOT<s>:SUBChannel<ch>:TSC <Value>

This command selects the training sequence of the specified slot and subchannel used by the mobile or base station.

This command is only available for AQPSK modulation.

Suffix:

<s> <0..7>
Number of slot to configure

<ch> <1|2>
Subchannel number

Query parameters:

<ResultType> TSC | SET
Queries the currently used TSC number or the set.

Parameters for setting and query:

<Value> 0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2 | USER
TSC number and Set or User TSC
Set 2 is only available for subchannel 2.
*RST: 0,1

Example:
// Subchannel 1: TSC 0 (Set 1)
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC 0,1`
// Subchannel 1: Query TSC number and Set number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?`
// -> 0,1
// Subchannel 1: Query TSC number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC? TSC`
// -> 0
// Subchannel 1: Query Set number
`CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC? SET`
// -> 1

Manual operation: See "Training Sequence TSC / Sync" on page 68

For a detailed example see chapter 11.10.2, "Programming Example: Measuring an AQPSK Signal", on page 273.

CONFigure[:MS]:CHANnel:SLOT<Number>:TADVance <Offset>

Specifies the position of an access burst within a single slot.

This command is only available for access bursts (see `CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE` on page 153).

Suffix:
<Number> <0..7>

Parameters for setting and query:
<Offset> offset from slot start in symbols
Range: 0 to 63
Increment: 10
*RST: 0

Example:
`CONF:CHAN:SLOT:TADV 1`

Manual operation: See "Timing Advance (Access Burst only)" on page 68

CONFigure[:MS]:CHANnel:SLOT<s>:TSC <Value>

This command selects the training sequence code TSC (Normal and Higher Symbol Rate Bursts) or training (synchronization) sequence TS (for Access Bursts) of the specified slot and subchannel used by the mobile or base station. See 3GPP TS 45.002, chapter 5.2 'Bursts'.

This command is not available for AQPSK modulation (use `CONFigure[:MS]:CHANnel:SLOT<s>:TSC` instead).

Suffix:
<s> 0..7
Number of the slot to configure

Query parameters:

<ResultType> TSC | SET

Queries the currently used TSC number or the set.
If no query parameter is defined, only the TS or the TSC is returned.

TSC
Only the TSC or TS is returned.

SET
The set of the TSC is returned.

Parameters for setting and query:

<Value> 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2 | TS0 | TS1 | TS2 | USER

training sequence for normal burst

0...7
One of the 7 pre-defined training sequence codes is used

0,1 | 0,2 | 1,1 | 1,2 | 2,1 | 2,2 | 3,1 | 3,2 | 4,1 | 4,2 | 5,1 | 5,2 | 6,1 | 6,2 | 7,1 | 7,2
TSC number and set for normal burst rates

TS0 | TS1 | TS2
Training (synchronization) sequence for access bursts

USER
A user-defined training sequence is used (see `CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER` on page 152).

*RST: 0

Example:

```
// TSC 3 (Set 1)
CONFigure:MS:CHANnel:SLOT0:TSC 3,1
// Query TSC number
CONFigure:MS:CHANnel:SLOT0:TSC? TSC
// -> 3
// Query Set number
CONFigure:MS:CHANnel:SLOT0:TSC? SET
// -> 1
```

Manual operation: See "Training Sequence TSC / Sync" on page 68

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:SLOT<s>:TSC:USER <Value>

This command sets the bits of the user definable TSC. The number of bits must be in accordance with the defined burst type and modulation (as indicated in Number of TSC bits depending on burst type and modulation). `CONFigure:MS:CHANnel:SLOT0:TSC USER` must be defined first (see `CONFigure[:MS]:CHANnel:SLOT<s>:TSC` on page 151).

Suffix:
<s> <0..7>
The slot to configure

Parameters for setting and query:
<Value> String containg the user defined bits, e.g. '10101111101010101100111100' for a GMSK normal burst.

Example: `CONF:CHAN:SLOT:TSC:USER`

Manual operation: See "User TSC / User Sync " on page 68

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

Table 11-2: Number of TSC bits depending on burst type and modulation

Burst Type	Modulation	Number of Bits
Normal	GMSK	26
Normal	8PSK	78
Normal	16QAM	104
Normal	32QAM	130
Higher Symbol Rate	QPSK	62
Higher Symbol Rate	16QAM	124
Higher Symbol Rate	32QAM	155
Access Burst	GMSK	41

CONFigure[:MS]:CHANnel:SLOT<Number>:TYPE <BurstType>

Specifies the type of the burst.

Suffix:
<Number> <0..7>

Parameters for setting and query:
<BurstType> NB | HB | AB

NB
Normal Burst

HB
Higher Symbol Rate Burst

AB
Access Burst

*RST: NB

Example: `CONF:CHAN:SLOT:TYPE NB`

Manual operation: See "Burst Type" on page 67

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

11.4.1.3 Multicarrier

The R&S FSW GSM application can also measure signals with multiple carriers. The following commands are required to provide information on the carriers in the input signal.

CONFigure[:MS]:MCARrier:ACTCarriers....154
CONFigure[:MS]:MCARrier:BTSClass....154
CONFigure[:MS]:MCARrier:MCBTs....154
CONFigure[:MS]:MCARrier[:STATe]....155

CONFigure[:MS]:MCARrier:ACTCarriers <NofActCarriers>

This parameter specifies the total number of active carriers of the multicarrier BTS to be measured. Its value affects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise"). The limit is changed by 10*log(N).

Parameters for setting and query:

<NofActCarriers> *RST: 1
Default unit: NONE

Example: `CONF:MCAR:ACTC`

Manual operation: See "No. of active Carriers" on page 70

CONFigure[:MS]:MCARrier:BTSClass <BTSClass>

This command defines the base station class. The specified BTS Class effects the calculation of the limits according to the 3GPP standard for the modulation spectrum measurement, see 3GPP2 TS 45.005 (chapter 4.2.1. "Spectrum due to modulation and wide band noise" and chapter 4.3.2 "Base Transceiver Station", search for "Multicarrier BTS").

Parameters for setting and query:

<BTSClass> Range: 1 to 2
*RST: 1
Default unit: NONE

Example: `CONF:MCAR:BTSClass`

Manual operation: See "BTS Class" on page 70

CONFigure[:MS]:MCARrier:MCBTs <MultiCarrierBTS>

This parameter informs the R&S FSW-K10 that the measured signal is a multicarrier signal. This function is only available if the "Device Type" is a "BTS" type (see `CONFigure[:MS]:DEVice:TYPE` on page 142). If active, a special multicarrier filter is switched into the demodulation path and further multicarrier-specific parameters become available.

Parameters for setting and query:

<MultiCarrierBTS> ON | OFF
*RST: OFF

Example: `CONF:MCAR:MCBT ON`

Manual operation: See "Multicarrier BTS" on page 69

CONFigure[:MS]:MCARrier[:STATe] <State>

This command is retained for compatibility with R&S FSW-K5 only. In new R&S FSW-K10 remote scripts use the commands described in the example below instead.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

*RST: 0

Example:
```
\\Switch on mode for multicarrier BTS measurements
CONFigure:MS:MCARrier:STATe ON
\\ Note: With the next command, a multicarrier pre-filter for the "Demod" measurements is also activated internally.
Switch on mode for multicarrier BTS measurements.
CONFigure:MS:MCARrier:MCBTs ON
\\ Select K5-compatible multicarrier pre-filter for PvT measurement.
CONFigure:MS:MCARrier:FILTer MC300
```

Mode: GSM

11.4.2 Input/Output Settings

The R&S FSW can analyze signals from different input sources (such as RF, power sensors etc.) and provide various types of output (such as noise or trigger signals). The following commands are required to configure data input and output.

- RF Input....155
- Configuring Digital I/Q Input and Output....157
- Configuring Input via the Analog Baseband Interface (R&S FSW-B71)....161
- Setting up Probes....163
- Configuring the Outputs....166

11.4.2.1 RF Input

INPut:ATTenuation:PROTection:RESet....156
INPut:COUPling....156
INPut:FILTer:HPASs[:STATe]....156
INPut:FILTer:YIG[:STATe]....156
INPut:IMPedance....157
INPut:SELect....157

INPut:ATTenuation:PROTection:RESet

This command resets the attenuator and reconnects the RF input with the input mixer after an overload condition occured and the protection mechanism intervened.The error status bit (bit 3 in the `STAT:QUES:POW` status register) and the `INPUT OVLD` message in the status bar are cleared.

The command works only if the overload condition has been eliminated first.

Usage: Event

INPut:COUPling <CouplingType>

This command selects the coupling type of the RF input.

Parameters:

<CouplingType>
AC
AC coupling
DC
DC coupling
*RST: AC

Example: `INP:COUP:DC`

Usage: SCPI confirmed

Manual operation: See "Input Coupling" on page 71

INPut:FILTer:HPASs[:STATe] <State>

Activates an additional internal high-pass filter for RF input signals from 1 GHz to 3 GHz. This filter is used to remove the harmonics of the R&S FSW in order to measure the harmonics for a DUT, for example.

This function requires option R&S FSW-B13.

(Note: for RF input signals outside the specified range, the high-pass filter has no effect. For signals with a frequency of approximately 4 GHz upwards, the harmonics are suppressed sufficiently by the YIG filter.)

Parameters:

<State>
ON | OFF
*RST: OFF

Usage: SCPI confirmed

Manual operation: See "High-Pass Filter 1...3 GHz" on page 72

INPut:FILTer:YIG[:STATe] <State>

This command turns the YIG-preselector on and off.

Note the special conditions and restrictions for the YIG filter described in "YIG-Preselector" on page 72.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1 (0 for I/Q Analyzer, GSM, VSA and MC Group Delay measurements)

Example: `INP:FILT:YIG OFF`
Deactivates the YIG-preselector.

Manual operation: See "YIG-Preselector" on page 72

INPut:IMPedance <Impedance>

This command selects the nominal input impedance of the RF input.

75 Ω should be selected if the 50 Ω input impedance is transformed to a higher impedance using a matching pad of the RAZ type (= 25 Ω in series to the input impedance of the instrument). The power loss correction value in this case is 1.76 dB = 10 log (75Ω/50Ω).

Parameters:

<Impedance> 50 | 75

*RST: 50 Ω

Example: `INP:IMP 75`

Usage: SCPI confirmed

Manual operation: See "Impedance" on page 71

INPut:SELect <Source>

This command selects the signal source for measurements, i.e. it defines which connector is used to input data to the R&S FSW. If no additional options are installed, only RF input is supported.

Parameters:

<Source> **RF**
Radio Frequency ("RF INPUT" connector)

*RST: RF

Manual operation: See "Digital I/Q Input State" on page 73
See "Analog Baseband Input State" on page 75

11.4.2.2 Configuring Digital I/Q Input and Output

Useful commands for digital I/Q data described elsewhere:

- `INST:SEL DIQ` (see `INPut:SELect` on page 157)
- `TRIGger[:SEQuence]:LEVel:BBPower` on page 175

Remote commands for the R&S DigIConf software

Remote commands for the R&S DigIConf software always begin with `SOURce:EBOX`. Such commands are passed on from the R&S FSW to the R&S DigIConf automatically which then configures the R&S EX-IQ-BOX via the USB connection.

All remote commands available for configuration via the R&S DigIConf software are described in the "R&S®EX-IQ-BOX Digital Interface Module R&S®DigIConf Software Operating Manual".

Example 1:

```
SOURce:EBOX:*RST
SOURce:EBOX:*IDN?
```

Result:

"Rohde&Schwarz,DigIConf,02.05.436 Build 47"

Example 2:

```
SOURce:EBOX:USER:CLOCk:REFerence:FREQuency 5MHZ
```

Defines the frequency value of the reference clock.

Remote commands exclusive to digital I/Q data input and output

INPut:DIQ:CDEVice....158
INPut:DIQ:RANGe[:UPPer]:AUTO....159
INPut:DIQ:RANGe:COUPling....160
INPut:DIQ:RANGe[:UPPer]....160
INPut:DIQ:RANGe[:UPPer]:UNIT....160
INPut:DIQ:SRATe....160
INPut:DIQ:SRATe:AUTO....161

INPut:DIQ:CDEVice

This command queries the current configuration and the status of the digital I/Q input from the optional Digital Baseband Interface (R&S FSW-B17).

For details see the section "Interface Status Information" for the Digital Baseband Interface (R&S FSW-B17) in the R&S FSW I/Q Analyzer User Manual.

Return values:

<ConnState> Defines whether a device is connected or not.

0
No device is connected.

1
A device is connected.

<DeviceName> Device ID of the connected device

<SerialNumber> Serial number of the connected device

<PortName> Port name used by the connected device

<SampleRate> Maximum or currently used sample rate of the connected device in Hz (depends on the used connection protocol version; indicated by <SampleRateType> parameter)

<MaxTransferRate> Maximum data transfer rate of the connected device in Hz

<ConnProtState> State of the connection protocol which is used to identify the connected device.

Not Started

Has to be Started

Started

Passed

Failed

Done

<PRBSTestState> State of the PRBS test.

Not Started

Has to be Started

Started

Passed

Failed

Done

<SampleRateType> **0**
Maximum sample rate is displayed

1
Current sample rate is displayed

<FullScaleLevel> The level (in dBm) that should correspond to an I/Q sample with the magnitude "1" (if transferred from connected device);
If not available, `9.97e37` is returned

Example:
```
INP:DIQ:CDEV?
```
Result:
```
1,SMU200A,103634,Out
A,70000000,100000000,Passed,Not Started,0,0
```

Manual operation: See "Connected Instrument" on page 74

INPut:DIQ:RANGe[:UPPer]:AUTO <State>

If enabled, the digital input full scale level is automatically set to the value provided by the connected device (if available).

This command is only available if the optional Digital Baseband interface (option R&S FSW-B17) is installed.

Parameters:

<State> ON | OFF

*RST: OFF

Manual operation: See "Full Scale Level" on page 73

INPut:DIQ:RANGe:COUPling <State>

If enabled, the reference level for digital input is adjusted to the full scale level automatically if the full scale level changes.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:
<State> ON | OFF
*RST: OFF

Manual operation: See "Adjust Reference Level to Full Scale Level" on page 74

INPut:DIQ:RANGe[:UPPer] <Level>

Defines or queries the "Full Scale Level", i.e. the level that corresponds to an I/Q sample with the magnitude "1".

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:
<Level> <numeric value>
Range: 1 µV to 7.071 V
*RST: 1 V

Manual operation: See "Full Scale Level" on page 73

INPut:DIQ:RANGe[:UPPer]:UNIT <Unit>

Defines the unit of the full scale level (see "Full Scale Level" on page 73). The availability of units depends on the measurement application you are using.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:
<Level> VOLT | DBM | DBPW | WATT | DBMV | DBUV | DBUA | AMPere
*RST: Volt

Manual operation: See "Full Scale Level" on page 73

INPut:DIQ:SRATe <SampleRate>

This command specifies or queries the sample rate of the input signal from the Digital Baseband Interface (R&S FSW-B17, see "Input Sample Rate" on page 73).

Parameters:

<SampleRate> Range: 1 Hz to 10 GHz
*RST: 32 MHz

Example: INP:DIQ:SRAT 200 MHz

Manual operation: See "Input Sample Rate" on page 73

INPut:DIQ:SRATe:AUTO <State>

If enabled, the sample rate of the digital I/Q input signal is set automatically by the connected device.

This command is only available if the optional Digital Baseband Interface (R&S FSW-B17) is installed.

Parameters:

<State> ON | OFF
*RST: OFF

Manual operation: See "Input Sample Rate" on page 73

11.4.2.3 Configuring Input via the Analog Baseband Interface (R&S FSW-B71)

The following commands are required to control the Analog Baseband Interface (R&S FSW-B71) in a remote environment.They are only available if this option is installed.

Useful commands for Analog Baseband data described elsewhere:

- `INP:SEL AIQ` (see `INPut:SELect` on page 157)
- `[SENSe:]FREQuency:CENTer` on page 167

Commands for the Analog Baseband calibration signal are described in the R&S FSW User Manual.

Remote commands exclusive to Analog Baseband data input and output

INPut:IQ:BALanced[:STATe]....161
INPut:IQ:FULLscale:AUTO....162
INPut:IQ:FULLscale:LEVel....162
INPut:IQ:TYPE....162
[SENSe:]SWAPiq....163

INPut:IQ:BALanced[:STATe] <State>

This command defines whether the input is provided as a differential signal via all 4 Analog Baseband connectors or as a plain I/Q signal via 2 simple-ended lines.

Parameters:

<State>

ON
Differential

OFF
Simple-ended

*RST: ON

Example: `INP:IQ:BAL OFF`

Manual operation: See "Input configuration" on page 76

INPut:IQ:FULLscale:AUTO <State>

This command defines whether the fullscale level (i.e. the maximum input power on the Baseband Input connector) is defined automatically according to the reference level, or manually.

Parameters:

<State>

ON
Automatic definition

OFF
Manual definition according to `INPut:IQ:FULLscale:LEVel` on page 162

*RST: ON

Example: `INP:IQ:FULL:AUTO OFF`

INPut:IQ:FULLscale:LEVel <PeakVoltage>

This command defines the peak voltage at the Baseband Input connector if the fullscale level is set to manual mode (see `INPut:IQ:FULLscale:AUTO` on page 162).

Parameters:

<PeakVoltage>

0.25 V | 0.5 V | 1 V | 2 V

Peak voltage level at the connector.
For probes, the possible fullscale values are adapted according to the probe's attenuation and maximum allowed power.

*RST: 1V

Example: `INP:IQ:FULL 0.5V`

INPut:IQ:TYPE <DataType>

This command defines the format of the input signal.

Parameters:

<DataType> IQ | I | Q

IQ
The input signal is filtered and resampled to the sample rate of the application.
Two input channels are required for each input signal, one for the in-phase component, and one for the quadrature component.

I
The in-phase component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0 (see `[SENSe:]FREQuency:CENTer` on page 167), the in-phase component of the input signal is down-converted first (Low IF I).

Q
The quadrature component of the input signal is filtered and resampled to the sample rate of the application. If the center frequency is not 0 (see `[SENSe:]FREQuency:CENTer` on page 167), the quadrature component of the input signal is down-converted first (Low IF Q).

*RST: IQ

Example: `INP:IQ:TYPE Q`

Manual operation: See "I/Q Mode" on page 75

[SENSe:]SWAPiq <State>

This command defines whether or not the recorded IQ pairs should be swapped (I<->Q) before being processed. Swapping I and Q inverts the sideband.

This is useful if the DUT interchanged the I and Q parts of the signal; then the R&S FSW can do the same to compensate for it.

Try this function if the TSC can not be found.

Parameters:

<State> **ON**
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: OFF

Manual operation: See "Swap I/Q" on page 76

11.4.2.4 Setting up Probes

Probes can be connected to the optional BASEBAND INPUT connectors, if the Analog Baseband interface (option R&S FSW-B71) is installed.

[SENSe:]PROBe<p>:ID:PARTnumber?....164
[SENSe:]PROBe<p>:ID:SRNumber?....164
[SENSe:]PROBe<p>:SETup:MODE....164
[SENSe:]PROBe<p>:SETup:NAME?....165
[SENSe:]PROBe<p>:SETup:STATe?....165
[SENSe:]PROBe<p>:SETup:TYPE?....166

[SENSe:]PROBe<p>:ID:PARTnumber?

Queries the R&S part number of the probe.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<PartNumber> Part number in a string.

Usage: Query only

[SENSe:]PROBe<p>:ID:SRNumber?

Queries the serial number of the probe.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<SerialNo> Serial number in a string.

Usage: Query only

[SENSe:]PROBe<p>:SETup:MODE <Mode>

Select the action that is started with the micro button on the probe head.

See also: "Microbutton Action" on page 77.

Suffix:
<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Parameters:
<Mode> **RSINgle**
Run single: starts one data acquisition.

NOACtion
Nothing is started on pressing the micro button.

*RST: RSINgle

Manual operation: See "Microbutton Action" on page 77

[SENSe:]PROBe<p>:SETup:NAME?

Queries the name of the probe.

Suffix:
<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:
<Name> Name string

Usage: Query only

[SENSe:]PROBe<p>:SETup:STATe?

Queries if the probe at the specified connector is active (detected) or not active (not detected). To switch the probe on, i.e. activate input from the connector, use `INP:SEL:AIQ` (see `INPut:SELect` on page 157).

Suffix:
<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:
<State> DETected | NDETected

*RST: NDETected

Usage: Query only

[SENSe:]PROBe<p>:SETup:TYPE?

Queries the type of the probe.

Suffix:

<p> 1 | 2 | 3
Selects the connector:
1 = Baseband Input I
2 = Baseband Input Q
3 = RF (currently not supported; use "1" with RF Input Connector setting "Baseband Input I")

Return values:

<Type> String containing one of the following values:
– None (no probe detected)
– active differential
– active single-ended

Usage: Query only

11.4.2.5 Configuring the Outputs

Configuring trigger input/output is described in chapter 11.4.4.2, "Configuring the Trigger Output", on page 178.

DIAGnostic:SERVice:NSOurce.....166

DIAGnostic:SERVice:NSOurce <State>

This command turns the 28 V supply of the BNC connector labeled NOISE SOURCE CONTROL on the front panel on and off.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `DIAG:SERV:NSO ON`

Manual operation: See "Noise Source" on page 83

11.4.3 Frontend Configuration

The following commands are required to configure frequency and amplitude settings, which represent the "frontend" of the measurement setup.

- Frequency....167
- Amplitude Settings....169
- Configuring the Attenuation....171

11.4.3.1 Frequency

The following commands are required to configure the frequencies to measure.

Useful commands for configuring frequencies described elsewhere:

- `CONFigure[:MS]:NETWork:FREQuency:BAND` on page 143
- `CONFigure[:MS]:NETWork[:TYPE]` on page 144

Remote commands exclusive to configuring frequencies:

CONFigure[:MS]:ARFCn....167
[SENSe:]FREQuency:CENTer....167
[SENSe:]FREQuency:CENTer:STEP....168
[SENSe:]FREQuency:CENTer:STEP:AUTO....168
[SENSe:]FREQuency:OFFSet....169

CONFigure[:MS]:ARFCn <Value>

This command specifies the Absolute Radio Frequency Channel Number (ARFCN) to be measured. Setting the ARFCN updates the frequency.

Parameters for setting and query:

<Value> numeric value

Range: 0 to 1023 (some values may not be allowed depending on the selected frequency band)

Default unit: NONE

Example: `CONF:ARFC 5`

Manual operation: See "ARFCN" on page 79

[SENSe:]FREQuency:CENTer <Frequency>

This command defines the center frequency.

If you change the frequency, the R&S FSW updates the "ARFCN" accordingly.

Parameters:

<Frequency> The allowed range and f_{max} is specified in the data sheet.

UP
Increases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

DOWN
Decreases the center frequency by the step defined using the `[SENSe:]FREQuency:CENTer:STEP` command.

*RST: fmax/2
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Usage: SCPI confirmed

Manual operation: See "Center Frequency" on page 76
See "Center Frequency" on page 79

[SENSe:]FREQuency:CENTer:STEP <StepSize>

This command defines the center frequency step size.

Parameters:

<StepSize> f_{max} is specified in the data sheet.

Range: 1 to fMAX
*RST: 0.1 x span
Default unit: Hz

Example:
```
FREQ:CENT 100 MHz
FREQ:CENT:STEP 10 MHz
FREQ:CENT UP
```
Sets the center frequency to 110 MHz.

Manual operation: See "Center Frequency Stepsize" on page 79

[SENSe:]FREQuency:CENTer:STEP:AUTO <State>

This command couples or decouples the center frequency step size to the span.

Parameters:

<State> ON | OFF | 0 | 1

*RST: 1

Example:
```
FREQ:CENT:STEP:AUTO ON
```
Activates the coupling of the step size to the span.

[SENSe:]FREQuency:OFFSet <Offset>

This command defines a frequency offset.

If this value is not 0 Hz, the application assumes that the input signal was frequency shifted outside the application. All results of type "frequency" will be corrected for this shift numerically by the application.

Parameters:

<Offset> Range: -100 GHz to 100 GHz
*RST: 0 Hz

Example: `FREQ:OFFS 1GHZ`

Usage: SCPI confirmed

Manual operation: See "Frequency Offset" on page 79

11.4.3.2 Amplitude Settings

The following commands are required to configure the amplitude settings in a remote environment.

Useful commands for amplitude settings described elsewhere:

- `INPut:COUPling` on page 156
- `INPut:IMPedance` on page 157
- `CONFigure[:MS]:POWer:CLASs` on page 145

Remote commands exclusive to amplitude settings:

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision....169
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel....170
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet....170
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]....170
INPut:GAIN:STATe....170
INPut:GAIN[:VALue]....170

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Parameters:

<Value> numeric value; the unit depends on the result display
Defines the range per division (total range = 10*<Value>)
*RST: depends on the result display

Example: `DISP:TRAC:Y:PDIV 10`
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Relative Scaling (Reference/ per Division)" on page 115
See "Per Division" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel <ReferenceLevel>

This command defines the reference level.

Example: `DISP:TRAC:Y:RLEV -60dBm`

Usage: SCPI confirmed

Manual operation: See "Reference Level" on page 81

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RLEVel:OFFSet <Offset>

This command defines a reference level offset.

Parameters:

<Offset> Range: -200 dB to 200 dB
*RST: 0dB

Example: `DISP:TRAC:Y:RLEV:OFFS -10dB`

Manual operation: See "Reference Level" on page 81
See "Shifting the Display (Offset)" on page 81

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe] <Range>

This command defines the display range of the y-axis.

Example: `DISP:TRAC:Y 110dB`

Usage: SCPI confirmed

INPut:GAIN:STATe <State>

This command turns the preamplifier on and off.

The command requires option R&S FSW-B24.

Parameters:

<State> ON | OFF
*RST: OFF

Example: `INP:GAIN:STAT ON`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Input Settings" on page 82
See "Preamplifier (option B24)" on page 82

INPut:GAIN[:VALue] <Gain>

This command selects the preamplification level if the preamplifier is activated (`INP:GAIN:STAT ON`, see `INPut:GAIN:STATe` on page 170).

The command requires option R&S FSW-B24.

Parameters:

<Gain> 15 dB | 30 dB

The availability of preamplification levels depends on the R&S FSW model.
- R&S FSW8: 15dB and 30 dB
- R&S FSW13: 15dB and 30 dB
- R&S FSW26: 30 dB

All other values are rounded to the nearest of these two.

*RST: OFF

Example: `INP:GAIN:VAL 30`
Switches on 30 dB preamplification.

Usage: SCPI confirmed

Manual operation: See "Input Settings" on page 82
See "Preamplifier (option B24)" on page 82

11.4.3.3 Configuring the Attenuation

INPut:ATTenuation....171
INPut:ATTenuation:AUTO....172
INPut:EATT....172
INPut:EATT:AUTO....172
INPut:EATT:STATe....172

INPut:ATTenuation <Attenuation>

This command defines the total attenuation for RF input.

If you set the attenuation manually, it is no longer coupled to the reference level, but the reference level is coupled to the attenuation. Thus, if the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> Range: see data sheet
Increment: 5 dB
*RST: 10 dB (AUTO is set to ON)

Example: `INP:ATT 30dB`
Defines a 30 dB attenuation and decouples the attenuation from the reference level.

Usage: SCPI confirmed

Manual operation: See "Mechanical Attenuation" on page 81
See "Attenuation Mode / Value" on page 81

INPut:ATTenuation:AUTO <State>

This command couples or decouples the attenuation to the reference level. Thus, when the reference level is changed, the R&S FSW determines the signal level for optimal internal data processing and sets the required attenuation accordingly.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:ATT:AUTO ON`
Couples the attenuation to the reference level.

Usage: SCPI confirmed

Manual operation: See "Mechanical Attenuation" on page 81
See "Attenuation Mode / Value" on page 81

INPut:EATT <Attenuation>

This command defines an electronic attenuation manually. Automatic mode must be switched off (`INP:EATT:AUTO OFF`, see `INPut:EATT:AUTO` on page 172).

If the current reference level is not compatible with an attenuation that has been set manually, the command also adjusts the reference level.

Parameters:

<Attenuation> attenuation in dB
Range: see data sheet
Increment: 1 dB
*RST: 0 dB (OFF)

Example:
```
INP:EATT:AUTO OFF
INP:EATT 10 dB
```

Manual operation: See "Using Electronic Attenuation (Option B25)" on page 82

INPut:EATT:AUTO <State>

This command turns automatic selection of the electronic attenuation on and off.

If on, electronic attenuation reduces the mechanical attenuation whenever possible.

Parameters:

<State> ON | OFF | 0 | 1
*RST: 1

Example: `INP:EATT:AUTO OFF`

Manual operation: See "Using Electronic Attenuation (Option B25)" on page 82

INPut:EATT:STATe <State>

This command turns the electronic attenuator on and off.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `INP:EATT:STAT ON`
Switches the electronic attenuator into the signal path.

Manual operation: See "Using Electronic Attenuation (Option B25)" on page 82

11.4.4 Triggering Measurements

Trigger settings determine when the input signal is measured.

- Configuring the Triggering Conditions....173
- Configuring the Trigger Output....178

11.4.4.1 Configuring the Triggering Conditions

The following commands are required to configure the trigger for the GSM measurement.

TRIGger[:SEQuence]:BBPower:HOLDoff....173
TRIGger[:SEQuence]:DTIMe....174
TRIGger[:SEQuence]:HOLDoff[:TIME]....174
TRIGger[:SEQuence]:IFPower:HOLDoff....174
TRIGger[:SEQuence]:IFPower:HYSTeresis....174
TRIGger[:SEQuence]:LEVel:BBPower....175
TRIGger[:SEQuence]:LEVel[:EXTernal<port>]....175
TRIGger[:SEQuence]:LEVel:IFPower....175
TRIGger[:SEQuence]:LEVel:IQPower....176
TRIGger[:SEQuence]:LEVel:RFPower....176
TRIGger[:SEQuence]:RFPower:HOLDoff....176
TRIGger[:SEQuence]:SLOPe....177
TRIGger[:SEQuence]:SOURce....177

TRIGger[:SEQuence]:BBPower:HOLDoff <Period>

This command defines the holding time before the baseband power trigger event.

The command requires the **Digital Baseband Interface (R&S FSW-B17)** or the **Analog Baseband Interface (R&S FSW-B71)**.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 174 command for new remote control programs.

Parameters:

<Period> Range: 150 ns to 1000 s
*RST: 150 ns

Example: `TRIG:SOUR BBP`
Sets the baseband power trigger source.
`TRIG:BBP:HOLD 200 ns`
Sets the holding time to 200 ns.

TRIGger[:SEQuence]:DTIMe <DropoutTime>

Defines the time the input signal must stay below the trigger level before a trigger is detected again.

Parameters:
<DropoutTime> Dropout time of the trigger.
Range: 0 s to 10.0 s
*RST: 0 s

Manual operation: See "Trigger Settings" on page 86
See "Drop-Out Time" on page 88

TRIGger[:SEQuence]:HOLDoff[:TIME] <Offset>

Defines the time offset between the trigger event and the start of the sweep (data capturing).

Parameters:
<Offset> *RST: 0 s

Example: `TRIG:HOLD 500us`

Manual operation: See "Trigger Settings" on page 86
See "Trigger Offset" on page 88

TRIGger[:SEQuence]:IFPower:HOLDoff <Period>

This command defines the holding time before the next trigger event.

Note that this command is available for **any trigger source**, not just IF Power.

Parameters:
<Period> *RST: 150 ns

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HOLD 200 ns`
Sets the holding time to 200 ns.

Manual operation: See "Trigger Settings" on page 86
See "Trigger Holdoff" on page 89

TRIGger[:SEQuence]:IFPower:HYSTeresis <Hysteresis>

This command defines the trigger hysteresis, which is only available for "IF Power" trigger sources.

Parameters:

<Hysteresis> Range: 3 dB to 50 dB
*RST: 3 dB

Example: `TRIG:SOUR IFP`
Sets the IF power trigger source.
`TRIG:IFP:HYST 10DB`
Sets the hysteresis limit value.

Manual operation: See "Trigger Settings" on page 86
See "Hysteresis" on page 89

TRIGger[:SEQuence]:LEVel:BBPower <Level>

This command sets the level of the baseband power trigger.

This command is available for the **Digital Baseband Interface (R&S FSW-B17)** and the **Analog Baseband Interface (R&S FSW-B71)**.

Parameters:

<Level> Range: -50 dBm to +20 dBm
*RST: -20 DBM

Example: `TRIG:LEV:BB -30DBM`

TRIGger[:SEQuence]:LEVel[:EXTernal<port>] <TriggerLevel>

This command defines the level the external signal must exceed to cause a trigger event.

Suffix:

<port> 1 | 2 | 3
Selects the trigger port.
1 = trigger port 1 (TRIGGER INPUT connector on front panel)
2 = trigger port 2 (TRIGGER INPUT/OUTPUT connector on front panel)
3 = trigger port 3 (TRIGGER3 INPUT/OUTPUT connector on rear panel)

Parameters:

<TriggerLevel> Range: 0.5 V to 3.5 V
*RST: 1.4 V

Example: `TRIG:LEV 2V`

Manual operation: See "Trigger Settings" on page 86
See "Trigger Level" on page 88

TRIGger[:SEQuence]:LEVel:IFPower <TriggerLevel>

This command defines the power level at the third intermediate frequency that must be exceeded to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:
<TriggerLevel> Range: -50 dBm to 20 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IFP -30DBM`

Manual operation: See "Trigger Settings" on page 86
See "Trigger Level" on page 88

TRIGger[:SEQuence]:LEVel:IQPower <TriggerLevel>

This command defines the magnitude the I/Q data must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

Parameters:
<TriggerLevel> Range: -130 dBm to 30 dBm
*RST: -20 dBm

Example: `TRIG:LEV:IQP -30DBM`

Manual operation: See "Trigger Settings" on page 86
See "Trigger Level" on page 88

TRIGger[:SEQuence]:LEVel:RFPower <TriggerLevel>

This command defines the power level the RF input must exceed to cause a trigger event. Note that any RF attenuation or preamplification is considered when the trigger level is analyzed.

The input signal must be between 500 MHz and 8 GHz.

Parameters:
<TriggerLevel> Range: -50 dBm to -10 dBm
*RST: -20 dBm

Example: `TRIG:LEV:RFP -30dBm`

Manual operation: See "Trigger Settings" on page 86
See "Trigger Level" on page 88

TRIGger[:SEQuence]:RFPower:HOLDoff <Time>

This command defines the holding time before the next trigger event. Note that this command is available for any trigger source, not just RF Power.

Note that this command is maintained for compatibility reasons only. Use the `TRIGger[:SEQuence]:IFPower:HOLDoff` on page 174 command for new remote control programs.

Parameters:
<Time> Default unit: S

TRIGger[:SEQuence]:SLOPe <Type>

For all trigger sources except time you can define whether triggering occurs when the signal rises to the trigger level or falls down to it.

Parameters:

<Type> POSitive | NEGative

POSitive
Triggers when the signal rises to the trigger level (rising edge).

NEGative
Triggers when the signal drops to the trigger level (falling edge).

*RST: POSitive

Example: `TRIG:SLOP NEG`

Manual operation: See "Trigger Settings" on page 86
See "Slope" on page 89

TRIGger[:SEQuence]:SOURce <Source>

This command selects the trigger source.

Note on external triggers:

If a measurement is configured to wait for an external trigger signal in a remote control program, remote control is blocked until the trigger is received and the program can continue. Make sure this situation is avoided in your remote control programs.

Parameters:

<Source>

IMMediate
Free Run

EXTernal
Trigger signal from the TRIGGER INPUT connector.

EXT2
Trigger signal from the TRIGGER INPUT/OUTPUT connector.
Note: Connector must be configured for "Input".

EXT3
Trigger signal from the TRIGGER 3 INPUT/ OUTPUT connector.
Note: Connector must be configured for "Input".

RFPower
First intermediate frequency

IFPower
Second intermediate frequency

IQPower
Magnitude of sampled I/Q data
For applications that process I/Q data, such as the I/Q Analyzer or optional applications.

*RST: IMMediate

Example: `TRIG:SOUR EXT`
Selects the external trigger input as source of the trigger signal

Manual operation: See "Trigger Settings" on page 86
See "Trigger Source" on page 86
See "Free Run" on page 87
See "External Trigger 1/2/3" on page 87
See "IQ Power" on page 87
See "IF Power" on page 88
See "RF Power" on page 88

11.4.4.2 Configuring the Trigger Output

The following commands are required to send the trigger signal to one of the variable TRIGGER INPUT/OUTPUT connectors. The tasks for manual operation are described in "Trigger 2/3" on page 84.

OUTPut:TRIGger<port>:DIRection....178
OUTPut:TRIGger<port>:LEVel....178
OUTPut:TRIGger<port>:OTYPe....179
OUTPut:TRIGger<port>:PULSe:IMMediate....179
OUTPut:TRIGger<port>:PULSe:LENGth....180

OUTPut:TRIGger<port>:DIRection <Direction>

This command selects the trigger direction.

Suffix:
<port> 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<Direction> **INPut**
Port works as an input.

OUTPut
Port works as an output.

*RST: INPut

Manual operation: See "Trigger 2/3" on page 84

OUTPut:TRIGger<port>:LEVel <Level>

This command defines the level of the signal generated at the trigger output.

This command works only if you have selected a user defined output with `OUTPut:TRIGger<port>:OTYPe`.

Suffix:
<port> 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<Level> **HIGH**
TTL signal.

LOW
0 V

*RST: LOW

Manual operation: See "Trigger 2/3" on page 84
See "Output Type" on page 84
See "Level" on page 84

OUTPut:TRIGger<port>:OTYPe <OutputType>

This command selects the type of signal generated at the trigger output.

Suffix:
<port> 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<OutputType> **DEVice**
Sends a trigger signal when the R&S FSW has triggered internally.

TARMed
Sends a trigger signal when the trigger is armed and ready for an external trigger event.

UDEFined
Sends a user defined trigger signal. For more information see `OUTPut:TRIGger<port>:LEVel`.

*RST: DEVice

Manual operation: See "Trigger 2/3" on page 84
See "Output Type" on page 84

OUTPut:TRIGger<port>:PULSe:IMMediate

This command generates a pulse at the trigger output.

Suffix:
<port> 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Usage: Event

Manual operation: See "Trigger 2/3" on page 84
See "Output Type" on page 84
See "Send Trigger" on page 85

OUTPut:TRIGger<port>:PULSe:LENGth <Length>

This command defines the length of the pulse generated at the trigger output.

Suffix:
<port> 2 | 3
Selects the trigger port to which the output is sent.
2 = trigger port 2 (front)
3 = trigger port 3 (rear)

Parameters:
<Length> Pulse length in seconds.

Manual operation: See "Trigger 2/3" on page 84
See "Output Type" on page 84
See "Pulse Length" on page 84

11.4.5 Data Acquisition

You must define how much and how often data is captured from the input signal.

MSRA operating mode
In MSRA operating mode, only the MSRA Master channel actually captures data from the input signal. The data acquisition settings for the GSM application in MSRA mode define the **application data extract** and **analysis interval**.

For details on the MSRA operating mode see chapter 5.16, "GSM in MSRA Operating Mode", on page 56 and the R&S FSW MSRA User Manual.

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11.4.5.1 Data Acquisition

The "Data Acquisition" settings define how long data is captured from the input signal by the R&S FSW GSM application.

[SENSe:]SWAPiq....181
[SENSe:]SWEep:TIME....181
TRACe:IQ:SRATe?....181
TRACe:IQ:BWIDth?....181

[SENSe:]SWAPiq <State>

This command defines whether or not the recorded IQ pairs should be swapped (I<->Q) before being processed. Swapping I and Q inverts the sideband.

This is useful if the DUT interchanged the I and Q parts of the signal; then the R&S FSW can do the same to compensate for it.

Try this function if the TSC can not be found.

Parameters:

<State>

ON
I and Q signals are interchanged
Inverted sideband, Q+j*I

OFF
I and Q signals are not interchanged
Normal sideband, I+j*Q

*RST: OFF

Manual operation: See "Swap I/Q" on page 76

[SENSe:]SWEep:TIME <Time>

This command defines the sweep (or: data capture) time.

Parameters:

<Time>

refer to data sheet

*RST: (AUTO is set to ON)

Example:
```
SWE:TIME 10s
```

Usage: SCPI confirmed

Manual operation: See "Capture Time" on page 92

TRACe:IQ:SRATe?

This command queries the final user sample rate for the acquired I/Q data.

Parameters:

<SampleRate>

The sample rate is a fixed value, depending on the frequency range to be measured (see also "Modulation Spectrum Table: Frequency List" on page 104).

Range: 100 Hz to 10 GHz continuously adjustable;
*RST: 32 MHz

Usage: Query only

Manual operation: See "Sample rate" on page 91

TRACe:IQ:BWIDth?

This command queries the bandwidth of the resampling filter.

The bandwidth of the resampling filter depends on the sampling rate.

Usage: Query only

Manual operation: See "Analysis Bandwidth" on page 91

11.4.5.2 Configuring and Performing Sweeps

The "Sweep" settings define how often data is captured from the input signal by the R&S FSW GSM application.

Useful commands for configuring sweeps described elsewhere:

- `[SENSe:]SWEep:TIME` on page 181
- `INITiate:REFResh` on page 216

Remote commands exclusive to configuring and performing sweeps

ABORt....182
INITiate:CONMeas....183
INITiate:CONTinuous....183
INITiate:DISPlay....184
INITiate[:IMMediate]....184
INITiate:SEQuencer:ABORt....185
INITiate:SEQuencer:IMMediate....185
INITiate:SEQuencer:MODE....185
[SENSe]:BURSt:COUNt....186
[SENSe:]SWEep:COUNt....186
[SENSe:]SWEep:COUNt:CURRent?....187
[SENSe:]SWEep:COUNt:TRGS:CURRent?....187

ABORt

This command aborts a current measurement and resets the trigger system.

To prevent overlapping execution of the subsequent command before the measurement has been aborted successfully, use the `*OPC?` or `*WAI` command after `ABOR` and before the next command.

For details see the "Remote Basics" chapter in the R&S FSW User Manual.

To abort a sequence of measurements by the Sequencer, use the `INITiate:SEQuencer:ABORt` on page 185 command.

Note on blocked remote control programs:

If a sequential command cannot be completed, for example because a triggered sweep never receives a trigger, the remote control program will never finish and the remote channel (GPIB, LAN or other interface) to the R&S FSW is blocked for further commands. In this case, you must interrupt processing on the remote channel first in order to abort the measurement.

To do so, send a "Device Clear" command from the control instrument to the R&S FSW on a parallel channel to clear all currently active remote channels. Depending on the used interface and protocol, send the following commands:

- **Visa**: `viClear()`
- **GPIB**: `ibclr()`
- **RSIB**: `RSDLLibclr()`

Now you can send the `ABORt` command on the remote channel performing the measurement.

Example: `ABOR;:INIT:IMM`
Aborts the current measurement and immediately starts a new one.

Example: `ABOR;*WAI`
`INIT:IMM`
Aborts the current measurement and starts a new one once abortion has been completed.

Usage: SCPI confirmed

INITiate:CONMeas

This command restarts a (single) measurement that has been stopped (using `INIT:CONT OFF`) or finished in single sweep mode.

The measurement is restarted at the beginning, not where the previous measurement was stopped.

As opposed to `INITiate[:IMMediate]`, this command does not reset traces in maxhold, minhold or average mode. Therefore it can be used to continue measurements using maxhold or averaging functions.

Example: (for Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Setting the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.
`INIT:CONM;*WAI`
Continues the measurement (next 20 sweeps) and waits for the end.
Result: Averaging is performed over 40 sweeps.

Manual operation: See "Continue Single Sweep" on page 94

INITiate:CONTinuous <State>

This command controls the sweep mode.

Note that in single sweep mode, you can synchronize to the end of the measurement with *OPC, *OPC? or *WAI. In continuous sweep mode, synchronization to the end of the measurement is not possible. Thus, it is not recommended that you use continuous sweep mode in remote control, as results like trace data or markers are only valid after a single sweep end synchronization.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

If the sweep mode is changed for a measurement channel while the Sequencer is active (see `INITiate:SEQuencer:IMMediate` on page 185) the mode is only considered the next time the measurement in that channel is activated by the Sequencer.

Parameters:

<State> ON | OFF | 0 | 1

ON | 1
Continuous sweep

OFF | 0
Single sweep

*RST: 1

Example: `INIT:CONT OFF`
Switches the sweep mode to single sweep.
`INIT:CONT ON`
Switches the sweep mode to continuous sweep.

Manual operation: See "Continuous Sweep/RUN CONT" on page 93

INITiate:DISPlay <State>

This command turns the display update during single sweep measurements on and off.

Parameters:

<State> ON | OFF

*RST: ON

INITiate[:IMMediate]

This command starts a (single) new measurement.

You can synchronize to the end of the measurement with *OPC, *OPC? or *WAI.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Example: (For Spectrum application:)
`INIT:CONT OFF`
Switches to single sweep mode.
`DISP:WIND:TRAC:MODE AVER`
Switches on trace averaging.
`SWE:COUN 20`
Sets the sweep counter to 20 sweeps.
`INIT;*WAI`
Starts the measurement and waits for the end of the 20 sweeps.

Manual operation: See "Single Sweep/ RUN SINGLE" on page 94

INITiate:SEQuencer:ABORt

This command stops the currently active sequence of measurements. The Sequencer itself is not deactivated, so you can start a new sequence immediately using `INITiate:SEQuencer:IMMediate` on page 185.

To deactivate the Sequencer use `SYSTem:SEQuencer` on page 141.

Usage: Event

INITiate:SEQuencer:IMMediate

This command starts a new sequence of measurements by the Sequencer. Its effect is similar to the `INITiate[:IMMediate]` command used for a single measurement.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 141).

Example:
`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

Usage: Event

INITiate:SEQuencer:MODE <Mode>

This command selects the way the R&S FSW application performs measurements sequentially.

Before this command can be executed, the Sequencer must be activated (see `SYSTem:SEQuencer` on page 141).

A detailed programming example is provided in the "Operating Modes" chapter in the R&S FSW User Manual.

Note: In order to synchronize to the end of a sequential measurement using *OPC, *OPC? or *WAI you must use `SINGle` Sequence mode.

For details on synchronization see the "Remote Basics" chapter in the R&S FSW User Manual.

Parameters:

<Mode>

SINGle
Each measurement is performed once (regardless of the channel's sweep mode), considering each channels' sweep count, until all measurements in all active channels have been performed.

CONTinuous
The measurements in each active channel are performed one after the other, repeatedly (regardless of the channel's sweep mode), in the same order, until the Sequencer is stopped.

CDEFined
First, a single sequence is performed. Then, only those channels in continuous sweep mode (`INIT:CONT ON`) are repeated.

*RST: CONTinuous

Example:

`SYST:SEQ ON`
Activates the Sequencer.
`INIT:SEQ:MODE SING`
Sets single sequence mode so each active measurement will be performed once.
`INIT:SEQ:IMM`
Starts the sequential measurements.

[SENSe]:BURSt:COUNt <Count>
[SENSe:]SWEep:COUNt <SweepCount>

These commands define the number of measurements the R&S FSW uses to average traces.

In case of continuous sweep measurements, the R&S FSW calculates the moving average over the Statistic Count.

In case of single sweep measurements, the R&S FSW stops the measurement and calculates the average after Statistic Count measurements.

Parameters:

<SweepCount>

If you set a sweep count of 0 or 1, the R&S FSW performs one single measurement.

Range: 0 to 200000
*RST: 200

Example:

`SWE:COUN 64`
Sets the number of measurements to 64.
`INIT:CONT OFF`
Switches to single sweep mode.
`INIT;*WAI`
Starts a series of 64 measurements and waits till its end.

Usage: SCPI confirmed

Manual operation: See "Statistic Count" on page 93

[SENSe:]SWEep:COUNt:CURRent?

This command returns the currently reached number of frames or measurements used for statistical evaluation. It can be used to track the progress of the averaging process until it reaches the set "Statistic Count" (see `[SENSe:]SWEep:COUNt` on page 186).

For Trigger to Sync measurements, use the `[SENSe:]SWEep:COUNt:TRGS:CURRent?` command to query the number of data acquisitions that contribute to the current result.

Usage: Query only

[SENSe:]SWEep:COUNt:TRGS:CURRent?

This command returns the currently reached number of data acquisitions that contribute to the Trigger to Sync result. It can be used to track the progress of the averaging process until it reaches the set "Statistic Count" (see `[SENSe:]SWEep:COUNt` on page 186).

For GSM measurements other than Trigger to Sync, use the `[SENSe:]SWEep:COUNt:CURRent?` command to query the number of frames or measurements that contribute to the current result.

Usage: Query only

11.4.6 Demodulation

Demodulation settings determine how frames and slots are detected in the input signal and which slots are to be evaluated.

The commands for frame and slot configuration are described in chapter 11.4.1.1, "Frame", on page 142 and chapter 11.4.1.2, "Slot", on page 147.

- Slot Scope....187
- Demodulation....189

11.4.6.1 Slot Scope

The slot scope defines which slots are to be evaluated (see also chapter 5.6, "Defining the Scope of the Measurement", on page 40).

CONFigure[:MS]:CHANnel:MSLots:MEASure....188
CONFigure[:MS]:CHANnel:MSLots:NOFSlots....188
CONFigure[:MS]:CHANnel:MSLots:OFFSet....188

CONFigure[:MS]:CHANnel:MSLots:MEASure <SlotToMeasure>

This command specifies the slot to be measured in single-slot measurements relative to the GSM frame boundary.

Parameters for setting and query:

<SlotToMeasure> Slot to measure in single-slot measurements.

*RST: 0 Slots
Default unit: NONE

Example: `CONF:CHAN:MSL:MEAS 5`

Manual operation: See "Slot to Measure" on page 96

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:MSLots:NOFSlots <NofSlotsToMeas>

This command specifies the number of slots to measure for the measurement interval of multi-slot measurements, i.e. the "Power vs Time" and "Transient Spectrum" measurements. Between 1 and 8 consecutive slots can be measured.

Parameters for setting and query:

<NofSlotsToMeas> Number of slots to measure.

Range: 1 to 8
*RST: 8 Slots
Default unit: NONE

Example: `CONF:CHAN:MSL:NOFS 5`

Manual operation: See "Number of Slots to measure" on page 96

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:CHANnel:MSLots:OFFSet <FirstSlotToMeas>

This command specifies the start for the measurement interval for multi-slot measurements, i.e. the "Power vs Time" and "Transient Spectrum" measurements, relative to the GSM frame boundary.

Parameters for setting and query:

<FirstSlotToMeas> 0-based index for the first slot to measure relative to the GSM frame start.

*RST: 0 Slots
Default unit: NONE

Example: `CONF:CHAN:MSL:OFFS 5`

Manual operation: See "First Slot to measure" on page 96

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

11.4.6.2 Demodulation

The demodulation settings provide additional information to optimize frame, slot and symbol detection.

CONFigure[:MS]:SYNC:MODE....189
CONFigure[:MS]:SYNC:ONLY....190
CONFigure[:MS]:SYNC:IQCThreshold....190
CONFigure[:MS]:DEMod:DECision....190
CONFigure[:MS]:DEMod:STDBits....191

CONFigure[:MS]:SYNC:MODE <Mode>

This command sets the synchronization mode of the R&S FSW-K10.

Parameters for setting and query:

<Mode> ALL | TSC | BURSt | NONE

ALL
First search for the power profile (burst search) according to the frame configuration in the capture buffer. Second, inside the found bursts search for the TSC of the "Slot to measure" as given in the frame configuration. "ALL" is usually faster than "TSC" for bursted signals.

TSC
Search the capture buffer for the TSC of the "Slot to measure" as given in the frame configuration. This mode corresponds to a correlation with the given TSC. This mode can be used for continous (but framed) signals or bursted signals.

BURSt
Search for the power profile (burst search) according to the frame configuration in the capture buffer.
Note: For "Burst" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

NONE
Do not synchronize at all. If an external or power trigger is chosen, the trigger instant corresponds to the frame start.
Tip: Manually adjust the trigger offset to move the burst to be analyzed under the mask in the "Power vs Time" measurement.
Note: For "None" no demodulation measurements (e.g. "Modulation Accuracy") are supported. Only "Power vs Time", "Modulation Spectrum", "Transient Spectrum" measurements are supported.

*RST: ALL

Example: `CONF:SYNC:MODE TSC`

Manual operation: See "Synchronization" on page 98

CONFigure[:MS]:SYNC:ONLY <State>

If activated, only results from frames (slots) where the "Slot to measure" was found are displayed and taken into account in the averaging of the results. The behavior of this function depends on the value of the"Synchronization" parameter (see `CONFigure[:MS]:SYNC:MODE` on page 189).

Parameters for setting and query:

<State> ON | OFF

*RST: ON

Example: `CONF:SYNC:MODE TSC`
Search the capture buffer for the TSC of the "Slot to measure" as given in the frame configuration.
`CONF:SYNC:ONLY ON`
Only if the TSC is found, the results are displayed.

Manual operation: See "Measure only on Sync" on page 99

CONFigure[:MS]:SYNC:IQCThreshold <Value>

This command sets the IQ correlation threshold. The IQ correlation threshold decides whether a burst is accepted if "Measure only on Sync" is activated. If the correlation value between the ideal IQ signal of the given TSC and the measured TSC is below the IQ correlation threshold, then the application reports "Sync not found" in the status bar. Additionally, such bursts are ignored if "Measure only on Sync" is activated.

Parameters for setting and query:

<Value> Range: 0 to 100
*RST: 85
Default unit: NONE

Example: `CONF:SYNC:IQCT 0`

Manual operation: See "I/Q Correlation Threshold" on page 99

CONFigure[:MS]:DEMod:DECision <Value>

This command determines how the symbols are detected in the demodulator. The setting of this parameter does not effect the demodulation of Normal Bursts with GMSK modulation.

For Normal Bursts with 8PSK, 16QAM, 32QAM or AQPSK modulation or Higher Symbol Rate Bursts with QPSK, 16QAM or 32QAM modulation use this parameter to get a trade-off between performance (symbol error rate of the K10) and measurement speed.

Parameters for setting and query:

<Value> AUTO | LINear | SEQuence

AUTO
Automatically selects the symbol decision method.

LINear
Linear symbol decision: Uses inverse filtering (a kind of zero-forcing filter) and a symbol-wise decision method. This method is recommended for high symbol to noise ratios, but not for Higher Symbol Rate bursts with a narrow pulse. The inverse filter colors the noise inside the signal bandwidth and therefore is not recommended for narrow-band signals or signals with a low signal to noise ratio. Peaks in the "EVM vs Time" measurement (see "EVM" on page 16) may occur if the "Linear" symbol decision algorithm fails. In that case use the "Sequence" method. Linear is the fastest option.

SEQuence
Symbol decision via sequence estimation. This method uses an algorithm that minimizes the symbol errors of the entire burst. It requires that the tail bits in the analyzed signal are correct. It has a better performance (lower symbol error rate) compared to the "Linear" method, especially at low signal to noise ratios, but with a loss of measurement speed. This method is recommended for normal bursts with 16QAM or 32QAM modulation and for Higher Symbol Rate bursts with a narrow pulse.

*RST: AUTO

Example: // Use 'sequence estimator' for the symbol decision
```
CONFigure:MS:DEMod:DECision SEQuence
```
For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

Manual operation: See "Symbol Decision" on page 99

CONFigure[:MS]:DEMod:STDBits <Value>

The demodulator of the R&S FSW GSM application requires the bits of the burst (Tail, Data, TSC, Data, Tail) to provide an ideal version of the measured signal. The "Data" bits can be random and are typically not known inside the demodulator of the GSM application.

Parameters for setting and query:

<Value> DETected | STD

DETected
The detected tail and TSC bits are used to construct the ideal signal.

STD
The standard tail and TSC bits (as set using `CONFigure[:MS]:CHANnel:SLOT<s>:TSC`) are used to construct the ideal signal.
Using the standard bits can be advantageous to verify whether the device under test sends the correct tail and TSC bits. Incorrect bits would lead to peaks in the "EVM vs Time" trace (see "EVM" on page 16) at the positions of the incorrect bits.

*RST: DETected

Example: // Replace detected Tail & TSC bits by the standard bits
```
CONFigure:MS:DEMod:STDBits STD
```
For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

Manual operation: See "Tail & TSC Bits" on page 100

11.4.7 Measurement

Measurement settings define how power or spectrum measurements are performed.

- Power vs Time....192
- Spectrum....194
- Trigger to Sync....198

11.4.7.1 Power vs Time

The "Power vs Time" filter is used to suppress out-of-band interference in the Power vs Time measurement (see chapter 5.7.2, "Power vs Time Filter", on page 44).

CONFigure:BURSt:PTEMplate:FILTer....192
CONFigure[:MS]:MCARrier:FILTer....193
CONFigure:BURSt:PTEMplate:TALign....193

CONFigure:BURSt:PTEMplate:FILTer <Type>

The PvT Filter controls the filter used to reduce the measurement bandwidth for single carrier "Power vs Time" measurements. The parameter is only available if "Multicarrier BTS" is switched off (see `CONFigure[:MS]:MCARrier:MCBTs` on page 154). Therefore the "PvT Filter" parameter in the "Multicarrier" tab is ignored in the single carrier case.

Parameters for setting and query:

<Type>

B600
Default Lowpass, 600 kHz

G500
Gaussian Filter, 500 kHz

G1000
Gaussian Filter, 1000 kHz

*RST: G1000

Example: `CONF:BURS:PTEM:FILT G500`

Manual operation: See "Single Carrier PvT Filter" on page 101

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure[:MS]:MCARrier:FILTer <Type>

This command controls the filter used to reduce the measurement bandwidth for multi-carrier "Power vs Time" measurements.

Parameters for setting and query:

<Type> MC400 | MC300

MC400
Recommended for measurements with multi channels of equal power.

MC300
Recommended for measurement scenarios where a total of six channels is active and the channel to be measured has a reduced power (e.g. 30 dB) compared to its adjacent channels.
The PvT filter is optimized to get smooth edges after filtering burst signals and to suppress adjacent, active channels.

*RST: MC400

Example: `CONF:MCAR:FILT MC400`

Manual operation: See "Multicarrier PvT Filter" on page 102

CONFigure:BURSt:PTEMplate:TALign <Mode>

This command controls the time-alignment of the limit lines for the "Power vs Time" measurement (see "PvT Full Burst" on page 25).

Parameters for setting and query:

<Mode> STMeasure | PSLot

STMeasure
For each slot the mid of TSC is derived from the measured mid of TSC of the "Slot to measure" and the timeslot lengths specified in the standard (see "Timeslot length" in 3GPP TS 45.010).

PSLot
For each slot the mid of TSC is measured. This provides reasonable time-alignment if the slot lengths are not according to standard. However, the "Power vs Time" limit check is also passed.

*RST: STMeasure

Example: `CONF:BURS:PTEM:TAL PSL`

Manual operation: See "Limit Line Time Alignment" on page 102

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

11.4.7.2 Spectrum

The modulation and transient spectrum measurements allow for further configuration.

CONFigure:SPECtrum:LIMit:LEFT....194
CONFigure:SPECtrum:LIMit:RIGHt....195
CONFigure:SPECtrum:SWITching:TYPE....195
CONFigure:SPECtrum:SWITching:LIMIT....195
CONFigure:SPECtrum:MODulation:LIMIT....196
CONFigure:WSPectrum:MODulation:LIST:SELect....196
[SENSe:]BANDwidth[:RESolution]:TYPE....197
READ:WSPectrum:MODulation:GATing?....197

CONFigure:SPECtrum:LIMit:LEFT <State>

This command controls the left limit check of the spectrum trace (spectrum graph measurement) and which offset frequencies in the table (spectrum list measurement) are checked against the limit. This command affects the "Modulation Spectrum" and "Transient Spectrum" measurements.

Note: For measurements on multicarrier signals, use either the check on the left or right side to measure the spectrum of the left- or right-most channel and to ignore the side where adjacent channels are located.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

1 | ON
check limit

0 | OFF
do not check limit

*RST: 1

Example: CONF:SPEC:LIM:LEFT OFF

Manual operation: See "Enable Left Limit/ Enable Right Limit" on page 103

CONFigure:SPECtrum:LIMit:RIGHt <State>

This command controls the right limit check of the spectrum trace (spectrum graph measurement) and which offset frequencies in the table (spectrum list measurement) are checked against the limit. This command affects the "Modulation Spectrum" and "Transient Spectrum" measurements.

Note: For measurements on multicarrier signals, use either the check on the left or right side to measure the spectrum of the left- or right-most channel and to ignore the side where adjacent channels are located.

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

1 | ON
check limit

0 | OFF
do not check limit

*RST: 1

Example: CONF:SPEC:LIM:LEFT OFF

Manual operation: See "Enable Left Limit/ Enable Right Limit" on page 103

CONFigure:SPECtrum:SWITching:TYPE <DetectorMode>

This command is retained for compatibility with R&S FSW-K5 only.

Parameters for setting and query:

<DetectorMode> PEAK | RMS

*RST: RMS

Example: CONFigure:SPECtrum:SWITching:TYPE?

Manual operation: See "Transient Spectrum: Reference Power" on page 104

CONFigure:SPECtrum:SWITching:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "Transient Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit. This command is only available when the "Transient Spectrum" measurement is selected (see CONFigure:SPECtrum:SWITching[:IMMediate] on page 264).

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example:
```
// Select Transient Spectrum measurement
// (measurement on captured I/Q data)
CONFigure:SPECtrum:SWITching:IMMediate
// Only list results are required
CONFigure:SPECtrum:SELect LIST
// Absolute power and limit results in dBm
CONFigure:SPECtrum:SWITching:LIMit ABSolute
// Run one measurement and query absolute list results
READ:SPECtrum:SWITching:ALL?
// -> 0,933200000,933200000,-101.55,-36.00,ABS,PASSED, ...
```

CONFigure:SPECtrum:MODulation:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "Modulation Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit. This command is only available when the "Modulation Spectrum" measurement is selected (see `LAYout:ADD[:WINDow]?` on page 201.

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example:
```
// Absolute power and limit results in dBm
CONFigure:SPECtrum:MODulation:LIMit ABSolute
// Run one measurement and query absolute list results
READ:SPECtrum:MODulation:ALL?
// -> 0,933200000,933200000,-108.66,-65.00,ABS,PASSED, ...
```

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

CONFigure:WSPectrum:MODulation:LIST:SELect <Mode>

For Modulation Spectrum Table measurements, this command controls whether offset frequencies are measured up to 1800 kHz or 5800 kHz.

Parameters for setting and query:

<Mode>

NARRow
The frequency list comprises offset frequencies up to 1.8 MHz from the carrier. The sample rate is 6.5 MHz.

NSParse
More compact version of "NARRow". The sample rate is 6.5 MHz.

WIDE
The frequency list comprises offset frequencies up to 6 MHz from the carrier. The sample rate is 19.5 MHz.

WSParse
More compact version of `WIDE`. The sample rate is 19.5 MHz.

*RST: WIDE

Example: `CONFigure:WSPectrum:MODulation:LIST:SELect NARRow`

Manual operation: See "Modulation Spectrum Table: Frequency List" on page 104

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

[SENSe:]BANDwidth[:RESolution]:TYPE <Type>

This command switches the filter type for the resolution filter for the "Modulation Spectrum", "Transient Spectrum" and "Wide Modulation Spectrum" measurement.

Parameters for setting and query:

<Type> NORMal | P5

NORMal
Gaussian filter with a 3 dB bandwidth of either 30 kHz or 100 kHz. This value is retained for compatibility with R&S FS-K5 only.

P5
5 Pole filter with a 3 dB bandwidth of either 30 kHz or 100 kHz. This filter is required by the GSM standard specification.

*RST: P5

Example: `BAND:TYPE NORM`

Manual operation: See "Filter Type" on page 104

READ:WSPectrum:MODulation:GATing?

This command reads out the gating settings for gated "Modulation Spectrum" measurements (see "Modulation Spectrum Table" on page 22).

The returned values can be used to set the gating interval for "list" measurements (i.e. a series of measurements in zero span mode at several offset frequencies). This is done in the "Spectrum" mode using the `SENSe:LIST` subsystem (see `[SENSe:]LIST:POWer:SET`).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see chapter 11.4.4, "Triggering Measurements", on page 173).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

Example: `READ:WSP:MOD:GAT?`
Result:
`0.00032303078,0.00016890001`

Usage: Query only

11.4.7.3 Trigger to Sync

CONFigure:TRGS:NOFBins <Value>

This command specifies the number of bins for the histogram of the "Trigger to Sync" measurement.

Parameters for setting and query:

<Value> numeric value

Number of bins

Range: 10 to 1000
*RST: 10
Default unit: NONE

Manual operation: See "No. of Bins" on page 106

CONFigure:TRGS:ADPSize <Value>

This command specifies the number of measurements after which the x-axis is fixed for the histogram calculation of the "Trigger to Sync" measurement.

Parameters for setting and query:

<Value> numeric value

Adaptive data size

Range: 10 to 1000
*RST: 100
Default unit: NONE

Manual operation: See "Adaptive Data Size" on page 106

11.4.8 Adjusting Settings Automatically

Some settings can be adjusted by the R&S FSW automatically according to the current measurement settings.

CONFigure[:MS]:AUTO:FRAMe ONCE....198
CONFigure[:MS]:AUTO:LEVel ONCE....199
CONFigure[:MS]:AUTO:TRIGger ONCE....199
CONFigure[:MS]:POWer:AUTO:SWEep:TIME....199

CONFigure[:MS]:AUTO:FRAMe ONCE <Value>

This command automatically performs a single measurement to detect the optimal frame configuration (i.e. frame and slot parameters) depending on the current measurement settings and results.

This function is **not** available in **MSRA** mode if the **Sequencer** is active.

Note that in Signal and Spectrum Analyzer mode, if the **Sequencer** is active, this command cannot be aborted via the `ABORt` command!

Example: `CONF:AUTO:FRAM ONCE`

Manual operation: See "Automatic Frame Configuration" on page 107

CONFigure[:MS]:AUTO:LEVel ONCE

This command is used to perform a single measurement to detect the required level automatically.

This command is **not** available in **MSRA** mode.

Note that this command cannot be aborted via the `ABORt` command!

Example: `CONF:AUTO:LEV ONCE`

Manual operation: See "Setting the Reference Level Automatically (Auto Level)" on page 107

CONFigure[:MS]:AUTO:TRIGger ONCE

This command is used to perform a single measurement that determines the trigger offset automatically.

This command is **not** available in **MSRA** mode.

Note that in Signal and Spectrum Analyzer mode, if the **Sequencer** is active, this command cannot be aborted via the `ABORt` command! This can lead to a hang up situation when no trigger signal is available or the trigger level is not set correctly. Use a `device clear` to abort the operation correctly.

Example: `CONF:AUTO:TRIG ONCE`

Usage: Setting only

Manual operation: See "Automatic Trigger Offset" on page 108

CONFigure[:MS]:POWer:AUTO:SWEep:TIME <Value>

This command is used to specify the auto track time, i.e. the capture time for auto detection.

This setting can currently only be defined in remote control, not in manual operation.

Tip: increase this value if less than every second GSM frame contains a signal.

Parameters for setting and query:

<Value> numeric value

Auto level measurement sweep time

Range: 0.01 to 1
*RST: 0.1 s
Default unit: S

Example: `CONF:POW:AUTO:SWE:TIME 0.01 MS`

11.5 Analyzing GSM Measurements

General analysis settings and functions concerning the trace, markers, windows etc. are available for GSM measurement results.

- Configuring the Result Display....200
- Result Config....207
- Configuring an Analysis Interval and Line (MSRA mode only)....215
- Zooming into the Display....217

11.5.1 Configuring the Result Display

The commands required to configure the screen display in a remote environment are described here.

- General Window Commands....200
- Working with Windows in the Display....201

11.5.1.1 General Window Commands

The following commands are required to configure general window layout, independant of the application.

DISPlay:FORMat....200
DISPlay[:WINDow<n>]:SIZE....200

DISPlay:FORMat <Format>

This command determines which tab is displayed.

Parameters:

<Format>

SPLit
Displays the MultiView tab with an overview of all active channels

SINGle
Displays the measurement channel that was previously focused.

*RST: SPL

Example: `DISP:FORM SING`

DISPlay[:WINDow<n>]:SIZE <Size>

This command maximizes the size of the selected result display window *temporarily*. To change the size of several windows on the screen permanently, use the `LAY:SPL` command (see `LAYout:SPLitter` on page 204).

Parameters:

<Size>

LARGe
Maximizes the selected window to full screen.
Other windows are still active in the background.

SMALl
Reduces the size of the selected window to its original size.
If more than one measurement window was displayed originally, these are visible again.

*RST: SMALl

Example:

```
DISP:WIND2:LARG
```

11.5.1.2 Working with Windows in the Display

The following commands are required to change the evaluation type and rearrange the screen layout for a measurement channel as you do using the SmartGrid in manual operation. Since the available evaluation types depend on the selected application, some parameters for the following commands also depend on the selected measurement channel.

LAYout:ADD[:WINDow]?....201
LAYout:CATalog[:WINDow]?....203
LAYout:IDENtify[:WINDow]?....203
LAYout:REMove[:WINDow]....203
LAYout:REPLace[:WINDow]....204
LAYout:SPLitter....204
LAYout:WINDow<n>:ADD?....206
LAYout:WINDow<n>:IDENtify?....206
LAYout:WINDow<n>:REMove....206
LAYout:WINDow<n>:REPLace....207

LAYout:ADD[:WINDow]? <WindowName>,<Direction>,<WindowType>

This command adds a window to the display.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

To replace an existing window, use the `LAYout:REPLace[:WINDow]` command.

Parameters:

<WindowName>

String containing the name of the existing window the new window is inserted next to.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<Direction>

LEFT | RIGHt | ABOVe | BELow

Direction the new window is added relative to the existing window.

<WindowType> text value

Type of result display (evaluation method) you want to add.
See the table below for available parameter values.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example: `LAY:ADD? '1',LEFT,MTAB`
Result:
`'2'`
Adds a new window named '2' with a marker table to the left of window 1.

Example: `LAY:ADD:WIND? '1',RIGH,MACC`
Adds a Modulation Accuracy display to the right of window 1.

Usage: Query only

Manual operation: See "Constellation" on page 15
See "EVM" on page 16
See "Magnitude Capture" on page 16
See "Magnitude Error" on page 17
See "Marker Table" on page 18
See "Modulation Accuracy" on page 18
See "Modulation Spectrum Graph" on page 20
See "Modulation Spectrum Table" on page 22
See "Phase Error" on page 23
See "Power vs Slot" on page 24
See "PvT Full Burst" on page 25
See "Transient Spectrum Graph" on page 27
See "Transient Spectrum Table" on page 28
See "Trigger to Sync Graph" on page 29
See "Trigger to Sync Table" on page 30

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

Table 11-3: <WindowType> parameter values for GSM application

Parameter value	Window type
CONStell	Constellation
ETIMe	EVM vs Time
MCAPture	Magnitude Capture
MERRor	Magnitude Error vs Time
MTABle	Marker Table
MACCuracy	Modulation Accuracy
MSFDomain	Modulation Spectrum Graph (Frequency domain)
MSTable	Modulation Spectrum Table
PERRor	Phase Error vs Time

Parameter value	Window type
PSTable	Power vs Slot
PTFull	PvT Full Burst
TGSGraph	Trigger vs Sync Graph
TGSTable	Trigger to Sync Table
TSFDomain	Transient Spectrum Graph (Frequency domain)
TSTable	Transient Spectrum Table

LAYout:CATalog[:WINDow]?

This command queries the name and index of all active windows from top left to bottom right. The result is a comma-separated list of values for each window, with the syntax:

<WindowName_1>,<WindowIndex_1>..<WindowName_n>,<WindowIndex_n>

Return values:

<WindowName> string

Name of the window.
In the default state, the name of the window is its index.

<WindowIndex> **numeric value**
Index of the window.

Example: `LAY:CAT?`
Result:
`'2',2,'1',1`
Two windows are displayed, named '2' (at the top or left), and '1' (at the bottom or right).

Usage: Query only

LAYout:IDENtify[:WINDow]? <WindowName>

This command queries the **index** of a particular display window.

Note: to query the **name** of a particular window, use the `LAYout:WINDow<n>:IDENtify?` query.

Query parameters:

<WindowName> String containing the name of a window.

Return values:

<WindowIndex> Index number of the window.

Usage: Query only

LAYout:REMove[:WINDow] <WindowName>

This command removes a window from the display.

Parameters:

<WindowName> String containing the name of the window.
In the default state, the name of the window is its index.

Usage: Event

LAYout:REPLace[:WINDow] <WindowName>,<WindowType>

This command replaces the window type (for example from "Diagram" to "Result Summary") of an already existing window while keeping its position, index and window name.

To add a new window, use the `LAYout:ADD[:WINDow]?` command.

Parameters:

<WindowName> String containing the name of the existing window.
By default, the name of a window is the same as its index. To determine the name and index of all active windows, use the `LAYout:CATalog[:WINDow]?` query.

<WindowType> Type of result display you want to use in the existing window.
See `LAYout:ADD[:WINDow]?` on page 201 for a list of available window types.

Example: `LAY:REPL:WIND '1',MTAB`
Replaces the result display in window 1 with a marker table.

LAYout:SPLitter <Index1>,<Index2>,<Position>

This command changes the position of a splitter and thus controls the size of the windows on each side of the splitter.

As opposed to the `DISPlay[:WINDow<n>]:SIZE` on page 200 command, the `LAYout:SPLitter` changes the size of all windows to either side of the splitter permanently, it does not just maximize a single window temporarily.

Note that windows must have a certain minimum size. If the position you define conflicts with the minimum size of any of the affected windows, the command will not work, but does not return an error.

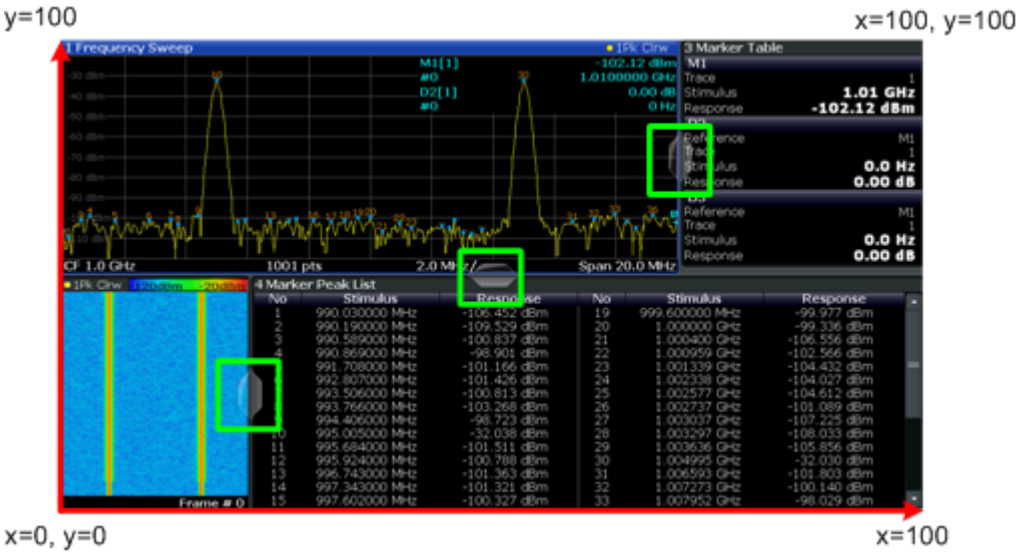


Fig. 11-1: SmartGrid coordinates for remote control of the splitters

Parameters:

<Index1> The index of one window the splitter controls.

<Index2> The index of a window on the other side of the splitter.

<Position> New vertical or horizontal position of the splitter as a fraction of the screen area (without channel and status bar and softkey menu). The point of origin (x = 0, y = 0) is in the lower left corner of the screen. The end point (x = 100, y = 100) is in the upper right corner of the screen. (See figure 11-1.)
The direction in which the splitter is moved depends on the screen layout. If the windows are positioned horizontally, the splitter also moves horizontally. If the windows are positioned vertically, the splitter also moves vertically.

Range: 0 to 100

Example: `LAY:SPL 1,3,50`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Table') to the center (50%) of the screen, i.e. in the figure above, to the left.

Example: `LAY:SPL 1,4,70`
Moves the splitter between window 1 ('Frequency Sweep') and 3 ('Marker Peak List') towards the top (70%) of the screen.
The following commands have the exact same effect, as any combination of windows above and below the splitter moves the splitter vertically.

```
LAY:SPL 3,2,70
LAY:SPL 4,1,70
LAY:SPL 2,1,70
```

LAYout:WINDow<n>:ADD? <Direction>,<WindowType>

This command adds a measurement window to the display. Note that with this command, the suffix <n> determines the existing window next to which the new window is added, as opposed to `LAYout:ADD[:WINDow]?`, for which the existing window is defined by a parameter.

To replace an existing window, use the `LAYout:WINDow<n>:REPLace` command.

This command is always used as a query so that you immediately obtain the name of the new window as a result.

Parameters:

<Direction> LEFT | RIGHt | ABOVe | BELow

<WindowType> Type of measurement window you want to add.
See `LAYout:ADD[:WINDow]?` on page 201 for a list of available window types.

Return values:

<NewWindowName> When adding a new window, the command returns its name (by default the same as its number) as a result.

Example:

```
LAY:WIND1:ADD? LEFT,MTAB
Result:
'2'
```

Adds a new window named '2' with a marker table to the left of window 1.

Usage: Query only

LAYout:WINDow<n>:IDENtify?

This command queries the **name** of a particular display window (indicated by the <n> suffix).

Note: to query the **index** of a particular window, use the `LAYout:IDENtify[:WINDow]?` command.

Return values:

<WindowName> String containing the name of a window.
In the default state, the name of the window is its index.

Usage: Query only

LAYout:WINDow<n>:REMove

This command removes the window specified by the suffix <n> from the display.

The result of this command is identical to the `LAYout:REMove[:WINDow]` command.

Usage: Event

LAYout:WINDow<n>:REPLace <WindowType>

This command changes the window type of an existing window (specified by the suffix <n>).

The result of this command is identical to the `LAYout:REPLace[:WINDow]` command.

To add a new window, use the `LAYout:WINDow<n>:ADD?` command.

Parameters:

<WindowType> Type of measurement window you want to replace another one with.
See `LAYout:ADD[:WINDow]?` on page 201 for a list of available window types.

11.5.2 Result Config

Some evaluation methods require or allow for additional settings to configure the result display. Note that the available settings depend on the selected window.

- Traces....207
- Marker....209
- Scaling....213

11.5.2.1 Traces

The number of available traces depends on the selected window (see "Specifics for" on page 62). Only graphical evaluations have trace settings.

DISPlay[:WINDow<n>]:TRACe<t>[:STATe]....207
DISPlay[:WINDow<n>]:TRACe<t>:MODE....207

DISPlay[:WINDow<n>]:TRACe<t>[:STATe] <State>

This command turns a trace on and off.

The measurement continues in the background.

Example: `DISP:TRAC3 ON`

Usage: SCPI confirmed

Manual operation: See "Trace 1/Trace 2/Trace 3/Trace 4" on page 110
See "Trace 1/Trace 2/Trace 3/Trace 4 (Softkeys)" on page 110

DISPlay[:WINDow<n>]:TRACe<t>:MODE <Mode>

This command controls whether a trace is displayed or not, and in which mode. Each trace can only display a certain mode, or nothing at all ("Blank"). table 11-4 below indicates which measurements can display which traces and which trace modes.

Note: even if a trace is not displayed, the results can still be queried (see `TRACe<n>[:DATA]?` on page 221).

In case of max hold, min hold or average trace mode, you can set the number of single measurements with `[SENSe:]SWEep:COUNt`. Note that synchronization to the end of the measurement is possible only in single sweep mode.

For a description of the trace modes see the "Trace Mode Overview" section in the base unit manual.

Parameters:

<Mode>

AVERage
The average is formed over several sweeps. The "Sweep/Average Count" determines the number of averaging procedures.

BLANk
Hides the selected trace.

MAXHold
The maximum value is determined over several sweeps and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is greater than the previous one.

MINHold
The minimum value is determined from several measurements and displayed. The R&S FSW saves the sweep result in the trace memory only if the new value is lower than the previous one.

PDFavg
The probability density function (PDF) of the average value.

WRITe
Overwrite mode: the trace is overwritten by each sweep.

Example:

```
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
// Modulation spectrum graph measurement
LAY:ADD:WIND? '1',RIGH,MSFD
//Result: 2
INITiate:IMMediate
// Switch off the display of all available traces
DISPlay:WINDow2:TRACe1:MODE BLANk
DISPlay:WINDow2:TRACe2:MODE BLANk
// Switch on the display of all available traces again
DISPlay:WINDow2:TRACe1:MODE AVERage
DISPlay:WINDow2:TRACe2:MODE WRITe
```

Manual operation:

See "Trigger to Sync Graph" on page 29
See "Trace Mode" on page 110

Table 11-4: Available traces and trace modes for the result diplays

Measurement	Trace 1	Trace 2	Trace 3	Trace 4
Magnitude Capture	WRITe	-	-	-
EVM Phase Error Magnitude Error PvT Full Burst	AVERage	MAXHold	MINHold	WRITe
Modulation Spectrum Graph Transient Spectrum Graph	AVERage	WRITe	-	-
Trigger to Sync	WRITe	PDFavg	-	-

11.5.2.2 Marker

Markers help you analyze your measurement results by determining particular values in the diagram. Thus you can extract numeric values from a graphical display. Up to 4 markers can be configured.

- Individual Marker Settings.....209
- General Marker Settings.....211
- Marker Positioning Settings.....211

Individual Marker Settings

In GSM evaluations, up to 4 markers can be activated in each diagram at any time. the following commandas are required to configure the markers.

CALCulate<n>:DELTamarker:AOFF.....209
CALCulate<n>:DELTamarker<m>[:STATe].....209
CALCulate<n>:DELTamarker<m>:TRACe.....210
CALCulate<n>:MARKer<m>[:STATe].....210
CALCulate<n>:MARKer<m>:AOFF.....210
CALCulate<n>:MARKer<m>:TRACe.....211

CALCulate<n>:DELTamarker:AOFF

This command turns all delta markers off.

Example: `CALC:DELT:AOFF`
Turns all delta markers off.

Usage: Event

CALCulate<n>:DELTamarker<m>[:STATe] <State>

This command turns delta markers on and off.

If necessary, the command activates the delta marker first.

No suffix at DELTamarker turns on delta marker 1.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:DELT2 ON`
Turns on delta marker 2.

Manual operation: See "Marker State" on page 112
See "Marker Type" on page 112

CALCulate<n>:DELTamarker<m>:TRACe <Trace>

This command selects the trace a delta marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> Trace number the marker is assigned to.

Example: `CALC:DELT2:TRAC 2`
Positions delta marker 2 on trace 2.

CALCulate<n>:MARKer<m>[:STATe] <State>

This command turns markers on and off. If the corresponding marker number is currently active as a deltamarker, it is turned into a normal marker.

Parameters:

<State> ON | OFF

*RST: OFF

Example: `CALC:MARK3 ON`
Switches on marker 3.

Manual operation: See "Marker State" on page 112
See "Marker Type" on page 112

CALCulate<n>:MARKer<m>:AOFF

This command turns all markers off.

Example: `CALC:MARK:AOFF`
Switches off all markers.

Usage: Event

Manual operation: See "All Markers Off" on page 112

CALCulate<n>:MARKer<m>:TRACe <Trace>

This command selects the trace the marker is positioned on.

Note that the corresponding trace must have a trace mode other than "Blank".

If necessary, the command activates the marker first.

Parameters:

<Trace> **1 to 4**
Trace number the marker is assigned to.

Example: `CALC:MARK3:TRAC 2`
Assigns marker 3 to trace 2.

Manual operation: See "Assigning the Marker to a Trace" on page 112

General Marker Settings

The following commands define general settings for all markers.

DISPlay:MTABle....211

DISPlay:MTABle <DisplayMode>

This command turns the marker table on and off.

Parameters:

<DisplayMode> **ON**
Turns the marker table on.

OFF
Turns the marker table off.

*RST: AUTO

Example: `DISP:MTAB ON`
Activates the marker table.

Manual operation: See "Marker Table Display" on page 113

Marker Positioning Settings

The following commands are required to set a specific marker to the result of a peak search.

CALCulate<n>:MARKer<m>:MAXimum:APEak....212
CALCulate<n>:MARKer<m>:MAXimum[:PEAK]....212
CALCulate<n>:MARKer<m>:MINimum[:PEAK]....212
CALCulate<n>:DELTamarker<m>:MAXimum:APEak....212
CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]....212
CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]....212

CALCulate<n>:MARKer<m>:MAXimum:APEak

sets the marker to the largest absolute peak value (maximum or minimum) of the selected trace.

Usage: Event

Manual operation: See "Max |Peak|" on page 114

CALCulate<n>:MARKer<m>:MAXimum[:PEAK]

This command moves a marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 114

CALCulate<n>:MARKer<m>:MINimum[:PEAK]

This command moves a marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 114

CALCulate<n>:DELTamarker<m>:MAXimum:APEak

This command positions the active marker or deltamarker on the largest absolute peak value (maximum or minimum) of the selected trace.

Usage: Event

CALCulate<n>:DELTamarker<m>:MAXimum[:PEAK]

This command moves a delta marker to the highest level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Peak Search" on page 114

CALCulate<n>:DELTamarker<m>:MINimum[:PEAK]

This command moves a delta marker to the minimum level.

If the marker is not yet active, the command first activates the marker.

Usage: Event

Manual operation: See "Search Minimum" on page 114

11.5.2.3 Scaling

The scaling for the vertical axis is highly configurable, using either absolute or relative values. These commands are described here.

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO....213
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum....213
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum....213
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision....214
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RPOSition....214
DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RVALue....214
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MAXimum....215
DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MINimum....215

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:AUTO <State>

If enabled, the Y-axis is scaled automatically according to the current measurement.

Parameters for setting and query:

<State>
OFF
Switch the function off
ON
Switch the function on
*RST: ON

Manual operation: See "Automatic Grid Scaling" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MAXimum <Value>

This command defines the maximum value of the y-axis for the selected result display.

Parameters:

<Value>
<numeric value>
*RST: depends on the result display
The unit and range depend on the result display.

Example:
```
DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
```
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:MINimum <Value>

This command defines the minimum value of the y-axis for the selected result display.

Parameters:

<Value>
<numeric value>
*RST: depends on the result display
The unit and range depend on the result display.

Example: DISP:TRAC:Y:MIN -60
DISP:TRAC:Y:MAX 0
Defines the y-axis with a minimum value of -60 and maximum value of 0.

Manual operation: See "Absolute Scaling (Min/Max Values)" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:PDIVision <Value>

This remote command determines the grid spacing on the Y-axis for all diagrams, where possible.

Parameters:
<Value> numeric value; the unit depends on the result display
Defines the range per division (total range = 10*<Value>)
*RST: depends on the result display

Example: DISP:TRAC:Y:PDIV 10
Sets the grid spacing to 10 units (e.g. dB) per division

Manual operation: See "Relative Scaling (Reference/ per Division)" on page 115
See "Per Division" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RPOSition <Position>

This command defines the vertical position of the reference level on the display grid.

The R&S FSW adjusts the scaling of the y-axis accordingly.

For measurements with the external generator (R&S FSW-B10) the command defines the position of the reference value.

Example: DISP:TRAC:Y:RPOS 50PCT

Usage: SCPI confirmed

Manual operation: See "Relative Scaling (Reference/ per Division)" on page 115
See "Ref Position" on page 115

DISPlay[:WINDow<n>]:TRACe:Y[:SCALe]:RVALue <Value>

The command defines the power value assigned to the reference position in the grid.

For external generator calibration measurements (requires External Generator Control option R&S FSW-B10), this command defines the power offset value assigned to the reference position.

Parameters:
<Value> *RST: 0 dBm, coupled to reference level

Example: DISP:TRAC:Y:RVAL -20dBm
Sets the power value assigned to the reference position to -20 dBm

Manual operation: See "Relative Scaling (Reference/ per Division)" on page 115
See "Ref Value" on page 115

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MAXimum <Value>

This command defines the maximum reference value assigned to the reference position in the specified window.

Parameters:
<Value> numeric value
Default unit: dBm

DISPlay[:WINDow<n>]:TRACe<t>:Y[:SCALe]:RVALue:MINimum <Value>

This command defines the minimum reference value assigned to the reference position in the specified window.

Parameters:
<Value> numeric_value
Default unit: dBm

11.5.3 Configuring an Analysis Interval and Line (MSRA mode only)

In MSRA operating mode, only the MSRA Master actually captures data; the MSRA applications define an extract of the captured data for analysis, referred to as the **analysis interval**. The **analysis line** is a common time marker for all MSRA applications.

For the GSM application, the commands to define the analysis interval are the same as those used to define the actual data acquisition (see chapter 11.4.5.1, "Data Acquisition", on page 180. Be sure to select the correct measurement channel before executing these commands.

In addition, a capture offset can be defined, i.e. an offset from the start of the captured data to the start of the analysis interval for the GSM measurement.

Remote commands exclusive to MSRA applications

The following commands are only available for MSRA application channels:

CALCulate:MSRA:ALINe:SHOW....215
CALCulate:MSRA:ALINe[:VALue]....216
CALCulate:MSRA:WINDow<n>:IVAL?....216
INITiate:REFResh....216
[SENSe:]MSRA:CAPTure:OFFSet....217

CALCulate:MSRA:ALINe:SHOW

This command defines whether or not the analysis line is displayed in all time-based windows in all MSRA applications and the MSRA Master.

Note: even if the analysis line display is off, the indication whether or not the currently defined line position lies within the analysis interval of the active application remains in the window title bars.

Parameters:

<State> ON | OFF

*RST: ON

CALCulate:MSRA:ALINe[:VALue] <Position>

This command defines the position of the analysis line for all time-based windows in all MSRA applications and the MSRA Master.

Parameters:

<Position> Position of the analysis line in seconds. The position must lie within the measurement time of the MSRA measurement.

Default unit: s

CALCulate:MSRA:WINDow<n>:IVAL?

This command queries the analysis interval for the window specified by the index <n>. This command is only available in application measurement channels, not the MSRA View or MSRA Master.

Return values:

<IntStart> Start value of the analysis interval in seconds

Default unit: s

<IntStop> Stop value of the analysis interval in seconds

Usage: Query only

INITiate:REFResh

This function is only available if the Sequencer is deactivated (`SYSTem:SEQuencer SYST:SEQ:OFF`) and only for applications in MSRA mode, not the MSRA Master.

The data in the capture buffer is re-evaluated by the currently active application only. The results for any other applications remain unchanged.

Example:

```
SYST:SEQ:OFF
```
Deactivates the scheduler
```
INIT:CONT OFF
```
Switches to single sweep mode.
```
INIT;*WAI
```
Starts a new data measurement and waits for the end of the sweep.
```
INST:SEL 'IQ ANALYZER'
```
Selects the IQ Analyzer channel.
```
INIT:REFR
```
Refreshes the display for the I/Q Analyzer channel.

Usage: Event

Manual operation: See "Refresh" on page 94

[SENSe:]MSRA:CAPTure:OFFSet <Offset>

This setting is only available for applications in MSRA mode, not for the MSRA Master. It has a similar effect as the trigger offset in other measurements.

Parameters:

<Offset> This parameter defines the time offset between the capture buffer start and the start of the extracted application data. The offset must be a positive value, as the application can only analyze data that is contained in the capture buffer.

Range: 0 to <Record length>
*RST: 0

Manual operation: See "Capture Offset" on page 92

11.5.4 Zooming into the Display

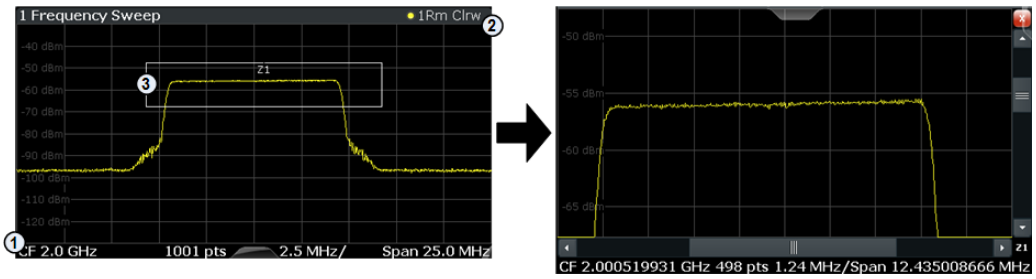
11.5.4.1 Using the Single Zoom

DISPlay[:WINDow<n>]:ZOOM:AREA....217
DISPlay[:WINDow<n>]:ZOOM:STATe....218

DISPlay[:WINDow<n>]:ZOOM:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Parameters:

<x1>,<y1>, <x2>,<y2>
Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

Manual operation: See "Single Zoom" on page 116

DISPlay[:WINDow<n>]:ZOOM:STATe <State>

This command turns the zoom on and off.

Parameters:

<State>
ON | OFF

*RST: OFF

Example:
```
DISP:ZOOM ON
```
Activates the zoom mode.

Manual operation: See "Single Zoom" on page 116
See "Restore Original Display" on page 116
See "Deactivating Zoom (Selection mode)" on page 117

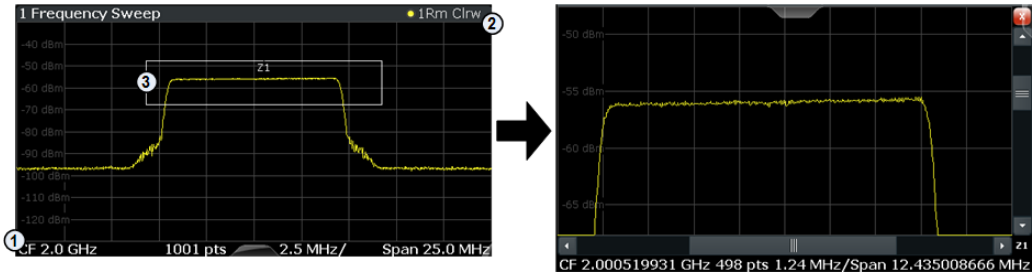
11.5.4.2 Using the Multiple Zoom

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA....218
DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe....219

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:AREA <x1>,<y1>,<x2>,<y2>

This command defines the zoom area for a multiple zoom.

To define a zoom area, you first have to turn the zoom on.



1 = origin of coordinate system (x1 = 0, y1 = 0)
2 = end point of system (x2 = 100, y2= 100)
3 = zoom area (e.g. x1 = 60, y1 = 30, x2 = 80, y2 = 75)

Suffix:

<zoom>
1...4
Selects the zoom window.

Parameters:

<x1>,<y1>, <x2>,<y2>
Diagram coordinates in % of the complete diagram that define the zoom area.
The lower left corner is the origin of coordinate system. The upper right corner is the end point of the system.

Range: 0 to 100
Default unit: PCT

Manual operation: See "Multiple Zoom" on page 116

DISPlay[:WINDow<n>]:ZOOM:MULTiple<zoom>:STATe <State>

This command turns the mutliple zoom on and off.

Suffix:

<zoom>
1...4
Selects the zoom window.
If you turn off one of the zoom windows, all subsequent zoom windows move up one position.

Parameters:

<State>
ON | OFF

*RST: OFF

Manual operation: See "Multiple Zoom" on page 116
See "Restore Original Display" on page 116
See "Deactivating Zoom (Selection mode)" on page 117

11.6 Retrieving Results

The following commands are required to retrieve the results from the GSM measurements.

- Graphical Results....219
- Measurement Results for TRACe<n>[:DATA]? TRACE<n>....223
- Magnitude Capture Results....225
- Modulation Accuracy Results....227
- Modulation Spectrum Results....237
- Power vs Slot Results....240
- Transient Spectrum Results....248
- Trigger to Sync Results....250
- Limit Check Results....251
- Retrieving Marker Results....252

11.6.1 Graphical Results

The results of the trace queries depend on the selected evaluation (see chapter 11.6.2, "Measurement Results for TRACe<n>[:DATA]? TRACE<n>", on page 223).

FORMat[:DATA]....220
FORMat:DEXPort:DSEParator....220
TRACe<n>[:DATA]?....221
TRACe<n>[:DATA]:X?....221
TRACe:IQ:DATA:MEMory?....222

FORMat[:DATA] <Format>

This command selects the data format that is used for transmission of trace data from the R&S FSW to the controlling computer.

Note that the command has no effect for data that you send to the R&S FSW. The R&S FSW automatically recognizes the data it receives, regardless of the format.

Parameters:

<Format>

ASCii
ASCii format, separated by commas.
This format is almost always suitable, regardless of the actual data format. However, the data is not as compact as other formats may be.

REAL,32
32-bit IEEE 754 floating-point numbers in the "definite length block format".
In the Spectrum application, the format setting `REAL` is used for the binary transmission of trace data.
For I/Q data, 8 bytes per sample are returned for this format setting.

*RST: ASCII

Example:
```
FORM REAL,32
```

Usage: SCPI confirmed

FORMat:DEXPort:DSEParator <Separator>

This command selects the decimal separator for data exported in ASCII format.

Parameters:

<Separator>

COMMa
Uses a comma as decimal separator, e.g. *4,05*.

POINt
Uses a point as decimal separator, e.g. *4.05*.

*RST: *RST has no effect on the decimal separator. Default is POINt.

Example:
```
FORM:DEXP:DSEP POIN
```
Sets the decimal point as separator.

TRACe<n>[:DATA]? <TraceNumber>

This command reads trace data out of the window specified by the suffix <n>. This command is only available for graphical result displays.

The returned values are scaled in the current level unit. The data format depends on `FORMat[:DATA]` on page 220.

For Constellation diagrams, the result is a vector of I/Q values for the measured points in the diagram. The result is returned as a list of (I,Q) value pairs.

Query parameters:

<TraceNumber> TRACe1 | TRACe2 | TRACe3 | TRACe4

Trace name to be read out

TRACe1
Average trace; (transient spectrum: Maximum trace)

TRACe2
Maximum trace

TRACe3
Minimum trace

TRACe4
Current trace

Example: `TRAC1:DATA? TRACe1`

Usage: Query only

Manual operation: See "EVM" on page 16
See "Magnitude Capture" on page 16
See "Magnitude Error" on page 17
See "Modulation Spectrum Graph" on page 20
See "Phase Error" on page 23
See "PvT Full Burst" on page 25
See "Transient Spectrum Graph" on page 27
See "Trigger to Sync Graph" on page 29

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

TRACe<n>[:DATA]:X? <TraceNumber>

This command reads the x-values (time in seconds) of the "Power vs Time" measurement (if active) out of the window specified by the suffix <n>.

If a trace number is defined as a parameter for this command, the x-values (time in seconds) of the "Trigger to Sync" measurement (if active) out of the window specified by the suffix <n> are returned.

For details see chapter 11.6.2.5, "Trigger to Sync Results", on page 225.

Query parameters:

<TraceNumber> TRACe1 | TRACe2 | TRACe3 | TRACe4

Trace number

TRACe1
Average trace; (Transient Spectrum: Maximum trace, Trigger to Sync: histogram values)

TRACe2
Maximum trace (Trigger to Sync: PDF of average trace)

TRACe3
Minimum trace

TRACe4
Current trace

Example: `TRACe2:DATA:X?`
Returns the Power vs Time values for the active trace in window 2.
`TRACe3:DATA:X? TRACe1`
Returns the Trigger to Sync values for trace 1 in window 3.

Usage: Query only

Manual operation: See "PvT Full Burst" on page 25
See "Trigger to Sync Graph" on page 29

TRACe:IQ:DATA:MEMory? [<OffsetSamples>,<NoOfSamples>]

This command queries the I/Q data currently stored in the memory of the R&S FSW.

By default, the command returns all I/Q data in the memory. You can, however, narrow down the amount of data that the command returns using the optional parameters.

By default, the amount of available data depends on `TRACe:IQ:SRATe?` on page 181 and `[SENSe:]SWEep:TIME` on page 181.

Parameters:

<OffsetSamples> Selects an offset at which the output of data should start in relation to the first data. If omitted, all captured samples are output, starting with the first sample.

Range: 0 to <# of samples> – 1, with <# of samples> being the maximum number of captured values
*RST: 0

<NoOfSamples> Number of samples you want to query, beginning at the offset you have defined. If omitted, all captured samples (starting at offset) are output.

Range: 1 to <# of samples> - <offset samples> with <# of samples> maximum number of captured values
*RST: <# of samples>

Return values:

<IQData> Measured value pair (I,Q) for each sample that has been recorded. The data format depends on `FORMat[:DATA]`.

Default unit: V

Example:

```
// Preset the instrument
*RST
// Enter GSM option
INST:SEL GSM
// Set center frequency to 935 MHz
FREQ:CENT 935MHZ
Sample Rate = 6.5 MHz
TRAC:IQ:SRAT 6.5MHz
Capture Time = 1.0 ms
SET:SWE:TIME 1 s
// Set statistic count to 1 to obtain the I/Q data of a single capture.
// Otherwise several captures are performed until the set
// statistic count is reached.
// I/Q data is returned from the last capture.
SWE:COUN 1
// Switch to single sweep mode
INIT:CONT OFF
// Start measurement and wait for sync
// This performs one sweep or a single I/Q capture.
INIT;*WAI
// Determine output format (binary float32)
FORMat REAL,32
// Read I/Q data of the entire capture buffer.
// 653751 samples are returned as I,Q,I,Q,...
// 653751 * 4 Bytes (float32) * 2 (I+Q) = 5230008 bytes
TRAC:IQ:DATA:MEM?
// Read 2048 I/Q samples starting at the beginning of data acquisition
TRAC:IQ:DATA:MEM? 0,2048
// Read 1024 I/Q samples starting at sample 2048.
TRAC:IQ:DATA:MEM? 2048,1024
```

Usage: Query only

11.6.2 Measurement Results for TRACe<n>[:DATA]? TRACE<n>

The evaluation method selected by the `LAY:ADD:WIND` command also affects the results of the trace data query (see TRACe<n>[:DATA]? TRACE<n>).

Details on the returned trace data depending on the evaluation method are provided here.

For details on the graphical results of these evaluation methods, see chapter 4, "Measurement Results", on page 15.

- EVM, Phase Error, Magnitude Error Trace Results....224
- PvT Full Burst Trace Results....224
- Modulation Spectrum and Transient Spectrum Graph Results....225
- Magnitude Capture Results....225
- Trigger to Sync Results....225

11.6.2.1 EVM, Phase Error, Magnitude Error Trace Results

The error vector magnitude (EVM), as well as the phase and magnitude errors are calculated and displayed for each symbol. Thus, the `TRAC:DATA?` query returns one value per symbol. The number of symbols depends on the burst type, modulation and number of carriers used for transmission, as well as the oversampling factor used internally by the R&S FSW GSM application. The following table provides an overview of the possible number of symbols.

Table 11-5: Number of trace result values for EVM, Phase Error, Magnitude Error measurements

Burst Type	Modulation	Multi-carrier BTS	No. of trace points	Comment
AB	GMSK	any	348 = 87 symbols (NSP) * ov	ov = oversampling factor = 4
NB	GMSK	OFF	588 = 147 symbols (NSP) * ov	ov = oversampling factor = 4 this corresponds to the "useful part" of the burst, see 3GPP TS 45.004, § "2.2 Start and stop of the burst"
NB	GMSK	ON	568 samples = 142 symbols (NSP) * ov	ov = oversampling factor = 4 This corresponds to the "useful part" of the burst, excluding the tail bits to allow the multicarrier filter to settle.
NB	not GMSK	any	142 symbols (NSP)	only one sample per symbol (ov=1) this corresponds to the "useful part" of the burst, excluding tail symbols see 3GPP TS 45.005, § "Annex G (normative): Calculation of Error Vector Magnitude"
HSR	any	any	169 symbols (RSP)	only one sample per symbol (ov=1) this corresponds to the "useful part" of the burst, excluding tail symbols see 3GPP TS 45.005, § "Annex G (normative): Calculation of Error Vector Magnitude"
NSP = Normal Symbol Period (= symbol duration for normal symbol rate / normal bursts) RSP = Reduced Symbol Period (= symbol duration for higher symbol rate / HSR bursts)				

11.6.2.2 PvT Full Burst Trace Results

The Power vs Time results depend on the number of slots that are measured, and thus the duration of the measurement. 30 additional symbols (NSP) are added at the beginning and at the end of the trace.

The number of trace result values is calculated as:

(30 + <NofSlots> * 157 + 30) * ov

where:

<NofSlots> = Number of Slots (Slot Scope)

ov = oversampling factor = 24

157 = length of a long slot (a slot can have a length of 156, 156.25 or 157 symbols (NSP))

11.6.2.3 Modulation Spectrum and Transient Spectrum Graph Results

Modulation Spectrum and Transient Spectrum Graphs consist of 1135 trace values (two less than in previous R&S signal and spectrum analyzers).

11.6.2.4 Magnitude Capture Results

The Magnitude Capture trace consists of 32001 trace values, regardless of the defined capture time and thus of the length of the capture buffer.

To retrieve the (complete) captured I/Q data, use the `MMEM:STOR:IQ:STAT` command, see `MMEMory:STORe:IQ:STATe` on page 255.

11.6.2.5 Trigger to Sync Results

The Trigger to Sync Graph results consist of two traces. Thus, the results of the `TRAC:DATA?` query depend on the <TraceNumber> parameter.

TRACe1: returns the height of the histogram bins; the number of values is defined by the number of bins (see `CONFigure:TRGS:NOFBins` on page 198)

TRACe2: returns the y-values for the probability density function (PDF) of the averaged values. The number of values depends on the number of data captures (Statistic Count, see `[SENSe:]SWEep:COUNt` on page 186).

X-values

The results of the `TRAC:DATA:X?` query also depend on the <TraceNumber> parameter:

TRACe1: returns the time (in s) at the center of each bin in the histogram.

TRACe2: returns the time (in s) for the PDF function of the averaged values

11.6.3 Magnitude Capture Results

The following commands are required to query the results of the "Magnitude Capture" evaluation.

FETCh:MCAPture:SLOTs:MEASure?.....226
FETCh:MCAPture:SLOTs:SCOPe.....226

FETCh:MCAPture:SLOTs:MEASure?

This command queries the positions of the slots to measure in the current capture buffer (indicated by blue bars in the result display).

Return values:

<Result> The result is a comma-separated list of positions for each slot with the following syntax:
`xPos[0],xLen[0], xPos[1],xLen[1],…`
where:
`xPos[i]` is the x-value (in seconds) of the i-th slot to measure
`xLen[i]` is the length of the i-th slot to measure (in seconds)
The number of values is 2* [the number of GSM frames in the current capture buffer]. If the number of frames defined by the statistic count all fit into the capture buffer at once, the number of values is 2*statistic count. If not, the number of values is 2*[the number of frames in the last capture].

Example: `FETCh:MCAPture:SLOTs:MEASure?`
Result for 3 slot scopes (e.g. after a single sweep with statistic count = 3)
`0.002261,0.000577,0.006876,0.000577,0.011492, 0.000577`

Usage: Query only

Manual operation: See "Magnitude Capture" on page 16

FETCh:MCAPture:SLOTs:SCOPe

This command queries the positions of the slot scopes in the current capture buffer (indicated by green bars in the result display).

Return values:

<Result> The result is a comma-separated list of positions for each scope with the following syntax:
`xPos[0],xLen[0], xPos[1],xLen[1],…`
where:
`xPos[i]` is the x-value (in seconds) of the i-th scope
`xLen[i]` is the length of the i-th scope (in seconds)
The number of values is 2* [the number of GSM frames in the current capture buffer]. If the number of frames defined by the statistic count all fit into the capture buffer at once, the number of values is 2*statistic count. If not, the number of values is 2*[the number of frames in the last capture].

Example: `FETCh:MCAPture:SLOTs:SCOPe?`
Result for 3 slots to measure (e.g. after a single sweep with statistic count = 3)
`0.002261,0.001154,0.006876,0.001154,0.011492, 0.001154`

Manual operation: See "Magnitude Capture" on page 16

11.6.4 Modulation Accuracy Results

The following commands are required to query the results of the "Modulation Accuracy" evaluation. For details on the individual results see table 4-1.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

Statistical results

For most results, both the current result and the statistical evaluation of all results over a number of frames (specified by Statistic Count) are provided.

For details on how the statistical evaluation is performed see table 4-2.

FETCh:BURSt[:MACCuracy]:ALL?....229
READ:BURSt[:MACCuracy]:ALL....229
FETCh:BURSt[:MACCuracy]:ADRoop:AVERage?....230
FETCh:BURSt[:MACCuracy]:ADRoop:CURRent?....230
FETCh:BURSt[:MACCuracy]:ADRoop:MAXimum?....230
FETCh:BURSt[:MACCuracy]:ADRoop:SDEViation?....230
READ:BURSt[:MACCuracy]:ADRoop:AVERage?....230
READ:BURSt[:MACCuracy]:ADRoop:CURRent?....230
READ:BURSt[:MACCuracy]:ADRoop:MAXimum?....230
READ:BURSt[:MACCuracy]:ADRoop:SDEViation?....230
FETCh:BURSt[:MACCuracy]:BPOWer:AVERage?....231
FETCh:BURSt[:MACCuracy]:BPOWer:CURRent?....231
FETCh:BURSt[:MACCuracy]:BPOWer:MAXimum?....231
FETCh:BURSt[:MACCuracy]:BPOWer:SDEViation?....231
READ:BURSt[:MACCuracy]:BPOWer:AVERage?....231
READ:BURSt[:MACCuracy]:BPOWer:CURRent?....231
READ:BURSt[:MACCuracy]:BPOWer:MAXimum?....231
READ:BURSt[:MACCuracy]:BPOWer:SDEViation?....231
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?....231
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?....231
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?....231
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?....231
READ:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?....231
READ:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?....231
READ:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?....231
READ:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?....231
FETCh:BURSt[:MACCuracy][:EVM]:RMS:AVERage?....232
FETCh:BURSt[:MACCuracy][:EVM]:RMS:CURRent?....232
FETCh:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?....232
FETCh:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?....232

READ:BURSt[:MACCuracy][:EVM]:RMS:AVERage?....232
READ:BURSt[:MACCuracy][:EVM]:RMS:CURRent?....232
READ:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?....232
READ:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?....232
FETCh:BURSt[:MACCuracy]:FREQuency:AVERage?....232
FETCh:BURSt[:MACCuracy]:FREQuency:CURRent?....232
FETCh:BURSt[:MACCuracy]:FREQuency:MAXimum?....232
FETCh:BURSt[:MACCuracy]:FREQuency:SDEViation?....232
READ:BURSt[:MACCuracy]:FREQuency:AVERage?....232
READ:BURSt[:MACCuracy]:FREQuency:CURRent?....232
READ:BURSt[:MACCuracy]:FREQuency:MAXimum?....232
READ:BURSt[:MACCuracy]:FREQuency:SDEViation?....232
FETCh:BURSt[:MACCuracy]:IQIMbalance:AVERage?....233
FETCh:BURSt[:MACCuracy]:IQIMbalance:CURRent?....233
FETCh:BURSt[:MACCuracy]:IQIMbalance:MAXimum?....233
FETCh:BURSt[:MACCuracy]:IQIMbalance:SDEViation?....233
READ:BURSt[:MACCuracy]:IQIMbalance:AVERage?....233
READ:BURSt[:MACCuracy]:IQIMbalance:CURRent?....233
READ:BURSt[:MACCuracy]:IQIMbalance:MAXimum?....233
READ:BURSt[:MACCuracy]:IQIMbalance:SDEViation?....233
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FETCh:BURSt[:MACCuracy]:IQOFfset:CURRent?....233
FETCh:BURSt[:MACCuracy]:IQOFfset:MAXimum?....233
FETCh:BURSt[:MACCuracy]:IQOFfset:SDEViation?....233
READ:BURSt[:MACCuracy]:IQOFfset:AVERage?....233
READ:BURSt[:MACCuracy]:IQOFfset:CURRent?....233
READ:BURSt[:MACCuracy]:IQOFfset:MAXimum?....233
READ:BURSt[:MACCuracy]:IQOFfset:SDEViation?....233
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?....234
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?....234
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?....234
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?....234
READ:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?....234
READ:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?....234
READ:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?....234
READ:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?....234
FETCh:BURSt[:MACCuracy]:MERRor:RMS:AVERage?....234
FETCh:BURSt[:MACCuracy]:MERRor:RMS:CURRent?....234
FETCh:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?....234
FETCh:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?....234
READ:BURSt[:MACCuracy]:MERRor:RMS:AVERage?....234
READ:BURSt[:MACCuracy]:MERRor:RMS:CURRent?....234
READ:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?....234
READ:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?....234
FETCh:BURSt[:MACCuracy]:OSUPpress:AVERage?....235
FETCh:BURSt[:MACCuracy]:OSUPpress:CURRent?....235
FETCh:BURSt[:MACCuracy]:OSUPpress:MAXimum?....235
FETCh:BURSt[:MACCuracy]:OSUPpress:SDEViation?....235
READ:BURSt[:MACCuracy]:OSUPpress:AVERage?....235
READ:BURSt[:MACCuracy]:OSUPpress:CURRent?....235

READ:BURSt[:MACCuracy]:OSUPpress:MAXimum?....235
READ:BURSt[:MACCuracy]:OSUPpress:SDEViation?....235
FETCh:BURSt[:MACCuracy]:PERCentile:EVM?....235
READ:BURSt[:MACCuracy]:PERCentile:EVM?....235
FETCh:BURSt[:MACCuracy]:PERCentile:MERRor?....236
READ:BURSt[:MACCuracy]:PERCentile:MERRor?....236
FETCh:BURSt[:MACCuracy]:PERCentile:PERRor?....236
READ:BURSt[:MACCuracy]:PERCentile:PERRor?....236
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?....236
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?....236
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?....236
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?....236
READ:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?....236
READ:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?....236
READ:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?....236
READ:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?....236
FETCh:BURSt[:MACCuracy]:PERRor:RMS:AVERage?....237
FETCh:BURSt[:MACCuracy]:PERRor:RMS:CURRent?....237
FETCh:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?....237
FETCh:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?....237
READ:BURSt[:MACCuracy]:PERRor:RMS:AVERage?....237
READ:BURSt[:MACCuracy]:PERRor:RMS:CURRent?....237
READ:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?....237
READ:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?....237

FETCh:BURSt[:MACCuracy]:ALL?
READ:BURSt[:MACCuracy]:ALL

This command starts the measurement and returns all the modulation accuracy results. For details on the individual parameters see "Modulation Accuracy" on page 18.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<MeasValue> <Error Vector Magnitude RMS>, <Error Vector Magnitude Peak>, <Magnitude Error RMS>, <Magnitude Error Peak>, <Phase Error RMS>, <Phase Error Peak>, <Origin Offset Suppression>, <IQ Offset>, <IQ Imbalance>,< Frequency Error>, <Burst Power>, <Amplitude Droop>, <95%ile EVM>, <95%ile Mag Error>, <95%ile Phase Error>

The results are output as a list of comma separated strings. For each result (except for %iles), the Current, Average, Maximum and Standard Deviation values are returned.

Example:

```
READ:BURS:ALL?
17.283994674682617,17.283994674682617,
17.283994674682617,0,24.647823333740234,
24.647823333740234,24.647823333740234,0,
1.0720701217651367,1.0720701217651367,
1.0720701217651367,0,1.0720850229263306,
1.0720850229263306,
1.0720850229263306,
0,9.8495550155639648,9.8495550155639648,
9.8495550155639648,
0,-14.069089889526367,14.069089889526367,
-14.069089889526367,
0,-0.091422632336616516,-0.091422632336616516,
-0.091422632336616516,
0,101.05810546875,101.05810546875,
101.05810546875,
0,0.036366362124681473,0.036366362124681473,
0.036366362124681473,
0,76.698326110839844,76.698326110839844,
76.698326110839844,0,
-112.8399658203125,-112.8399658203125,
-112.8399658203125,0,
0.083038687705993652,0.083038687705993652,
0.083038687705993652,0,
24.07130241394043,1.0950000286102295,
14.060454368591309
```

Manual operation: See "Modulation Accuracy" on page 18

FETCh:BURSt[:MACCuracy]:ADRoop:AVERage?
FETCh:BURSt[:MACCuracy]:ADRoop:CURRent?
FETCh:BURSt[:MACCuracy]:ADRoop:MAXimum?
FETCh:BURSt[:MACCuracy]:ADRoop:SDEViation?
READ:BURSt[:MACCuracy]:ADRoop:AVERage?
READ:BURSt[:MACCuracy]:ADRoop:CURRent?
READ:BURSt[:MACCuracy]:ADRoop:MAXimum?
READ:BURSt[:MACCuracy]:ADRoop:SDEViation?

This command starts the measurement and reads out the result of the Amplitude Droop.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Amplitude Droop see table 4-1.

Return values:

<Result> numeric value
Amplitude droop
Default unit: dB

Example: `READ:BURS:ADR:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:BPOWer:AVERage?
FETCh:BURSt[:MACCuracy]:BPOWer:CURRent?
FETCh:BURSt[:MACCuracy]:BPOWer:MAXimum?
FETCh:BURSt[:MACCuracy]:BPOWer:SDEViation?
READ:BURSt[:MACCuracy]:BPOWer:AVERage?
READ:BURSt[:MACCuracy]:BPOWer:CURRent?
READ:BURSt[:MACCuracy]:BPOWer:MAXimum?
READ:BURSt[:MACCuracy]:BPOWer:SDEViation?

This command starts the measurement and reads out the result of the Burst Power.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Burst Power see table 4-1.

Return values:

<Result> numeric value
Burst Power
Default unit: dB

Example: `READ:BURS:BPOW:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?
READ:BURSt[:MACCuracy][:EVM]:PEAK:AVERage?
READ:BURSt[:MACCuracy][:EVM]:PEAK:CURRent?
READ:BURSt[:MACCuracy][:EVM]:PEAK:MAXimum?
READ:BURSt[:MACCuracy][:EVM]:PEAK:SDEViation?

This command starts the measurement and reads out the peak result of the Error Vector Magnitude taken over the selected number of bursts. When the measurement is started the analyzer is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the EVM results see table 4-1

Return values:

<Result> numeric value
EVM
Default unit: NONE

Example: `READ:BURS:PEAK:AVER?`

Usage: Query only

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

FETCh:BURSt[:MACCuracy][:EVM]:RMS:AVERage?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:CURRent?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?
FETCh:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?
READ:BURSt[:MACCuracy][:EVM]:RMS:AVERage?
READ:BURSt[:MACCuracy][:EVM]:RMS:CURRent?
READ:BURSt[:MACCuracy][:EVM]:RMS:MAXimum?
READ:BURSt[:MACCuracy][:EVM]:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Error Vector Magnitude.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the EVM results see table 4-1.

Return values:

<Result> numeric value
EVM
Default unit: NONE

Example: `READ:BURS:RMS:SDEV?`

Usage: Query only

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

FETCh:BURSt[:MACCuracy]:FREQuency:AVERage?
FETCh:BURSt[:MACCuracy]:FREQuency:CURRent?
FETCh:BURSt[:MACCuracy]:FREQuency:MAXimum?
FETCh:BURSt[:MACCuracy]:FREQuency:SDEViation?
READ:BURSt[:MACCuracy]:FREQuency:AVERage?
READ:BURSt[:MACCuracy]:FREQuency:CURRent?
READ:BURSt[:MACCuracy]:FREQuency:MAXimum?
READ:BURSt[:MACCuracy]:FREQuency:SDEViation?

This command starts the measurement and reads out the result of the Frequency Error.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Frequency Error see table 4-1.

Return values:

<Result> numeric value
Frequency error
Default unit: Hz

Example: `READ:BURS:FREQ:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:IQIMbalance:AVERage?
FETCh:BURSt[:MACCuracy]:IQIMbalance:CURRent?
FETCh:BURSt[:MACCuracy]:IQIMbalance:MAXimum?
FETCh:BURSt[:MACCuracy]:IQIMbalance:SDEViation?
READ:BURSt[:MACCuracy]:IQIMbalance:AVERage?
READ:BURSt[:MACCuracy]:IQIMbalance:CURRent?
READ:BURSt[:MACCuracy]:IQIMbalance:MAXimum?
READ:BURSt[:MACCuracy]:IQIMbalance:SDEViation?

This command starts the measurement and reads out the result of the I/Q Imbalance.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the I/Q Imbalance see table 4-1.

Return values:

<Result> numeric value
I/Q Imbalance
Default unit: NONE

Example: `READ:BURS:IQIM:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:IQOFfset:AVERage?
FETCh:BURSt[:MACCuracy]:IQOFfset:CURRent?
FETCh:BURSt[:MACCuracy]:IQOFfset:MAXimum?
FETCh:BURSt[:MACCuracy]:IQOFfset:SDEViation?
READ:BURSt[:MACCuracy]:IQOFfset:AVERage?
READ:BURSt[:MACCuracy]:IQOFfset:CURRent?
READ:BURSt[:MACCuracy]:IQOFfset:MAXimum?
READ:BURSt[:MACCuracy]:IQOFfset:SDEViation?

This command starts the measurement and reads out the standard deviation measurement of the IQ Offset taken over the selected number of bursts. When the measurement is started the analyzer is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result> numeric value
Standard deviation
Default unit: NONE

Example: `READ:BURS:IQOF:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?
READ:BURSt[:MACCuracy]:MERRor:PEAK:AVERage?
READ:BURSt[:MACCuracy]:MERRor:PEAK:CURRent?
READ:BURSt[:MACCuracy]:MERRor:PEAK:MAXimum?
READ:BURSt[:MACCuracy]:MERRor:PEAK:SDEViation?

This command starts the measurement and reads out the peak value of the Magnitude Error.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Magnitude Error see table 4-1.

Return values:

<Result> numeric value
Magnitude error
Default unit: NONE

Example: `READ:BURS:MERR:PEAK:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:MERRor:RMS:AVERage?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:CURRent?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?
FETCh:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?
READ:BURSt[:MACCuracy]:MERRor:RMS:AVERage?
READ:BURSt[:MACCuracy]:MERRor:RMS:CURRent?
READ:BURSt[:MACCuracy]:MERRor:RMS:MAXimum?
READ:BURSt[:MACCuracy]:MERRor:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Magnitude Error.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Magnitude Error see table 4-1.

Return values:

<Result> numeric value
Magnitude error
Default unit: NONE

Example: `READ:BURS:MERR:RMS:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:OSUPpress:AVERage?
FETCh:BURSt[:MACCuracy]:OSUPpress:CURRent?
FETCh:BURSt[:MACCuracy]:OSUPpress:MAXimum?
FETCh:BURSt[:MACCuracy]:OSUPpress:SDEViation?
READ:BURSt[:MACCuracy]:OSUPpress:AVERage?
READ:BURSt[:MACCuracy]:OSUPpress:CURRent?
READ:BURSt[:MACCuracy]:OSUPpress:MAXimum?
READ:BURSt[:MACCuracy]:OSUPpress:SDEViation?

This command starts the measurement and reads out the result of the I/Q Offset Suppression.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the I/Q Offset Suppression see table 4-1.

Return values:

<Result> numeric value
I/Q offset suppression
Default unit: dB

Example: `READ:BURS:OSUP:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERCentile:EVM?
READ:BURSt[:MACCuracy]:PERCentile:EVM?

This command starts the measurement and reads out the 95 % percentile of the Error Vector Magnitude measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result> numeric value
Default unit: NONE

Example: `READ:BURS:PERC:EVM?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERCentile:MERRor?
READ:BURSt[:MACCuracy]:PERCentile:MERRor?

This command starts the measurement and reads out the 95 % percentile of the Magnitude Error measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result> numeric value
Default unit: NONE

Example: `READ:BURS:PERC:MERR?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERCentile:PERRor?
READ:BURSt[:MACCuracy]:PERCentile:PERRor?

This command starts the measurement and reads out the 95 % percentile of the Phase Error measurement taken over the selected number of frames.

When the measurement is started the R&S FSW GSM application is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

Return values:

<Result> numeric value
Phase error
Default unit: NONE

Example: `READ:BURS:PERC:PERR?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?
FETCh:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?
READ:BURSt[:MACCuracy]:PERRor:PEAK:AVERage?
READ:BURSt[:MACCuracy]:PERRor:PEAK:CURRent?
READ:BURSt[:MACCuracy]:PERRor:PEAK:MAXimum?
READ:BURSt[:MACCuracy]:PERRor:PEAK:SDEViation?

This command starts the measurement and reads out the peak value of the Phase Error.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Phase Error results see table 4-1.

Return values:

<Result> numeric value
Phase error
Default unit: NONE

Example: `READ:BURS:PERR:PEAK:SDEV?`

Usage: Query only

FETCh:BURSt[:MACCuracy]:PERRor:RMS:AVERage?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:CURRent?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?
FETCh:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?
READ:BURSt[:MACCuracy]:PERRor:RMS:AVERage?
READ:BURSt[:MACCuracy]:PERRor:RMS:CURRent?
READ:BURSt[:MACCuracy]:PERRor:RMS:MAXimum?
READ:BURSt[:MACCuracy]:PERRor:RMS:SDEViation?

This command starts the measurement and reads out the RMS value of the Phase Error.

When the measurement is started the R&S FSW is automatically set to single sweep. Further results of the measurement can then be queried without restart of the measurement via the `FETCh:BURSt` subsystem.

For details on the Phase Error results see table 4-1.

Return values:

<Result> numeric value
Phase error
Default unit: NONE

Example: `READ:BURS:PERR:RMS:SDEV?`

Usage: Query only

11.6.5 Modulation Spectrum Results

The following commands are required to query the results of the "Modulation Spectrum Table" evaluation. For details on the individual results see "Modulation Spectrum Table" on page 22.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

FETCh:SPECtrum:MODulation[:ALL]?....238
READ:SPECtrum:MODulation[:ALL]....238
FETCh:SPECtrum:MODulation:REFerence?....239
READ:SPECtrum:MODulation:REFerence[:IMMediate]?....239
READ:SPECtrum:MODulation:GATing?....239
READ:WSPectrum:MODulation:GATing?....239

FETCh:SPECtrum:MODulation[:ALL]?
READ:SPECtrum:MODulation[:ALL]

This command starts the measurement and returns the modulation spectrum of the mobile or base station. This command is only available for "Modulation Spectrum Table" evaluations (see "Modulation Spectrum Table" on page 22).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas, with one list for each measured frequency in the frequency list.

Return values:

<Placeholder> curently irrelevant

<Freq1> Absolute offset frequency in Hz

<Freq2> Absolute offset frequency in Hz

<Level> Measured level at the offset frequency in dB or dBm (depending on `CONF:SPEC:MOD:LIM`).

<Limit> Limit at the offset frequency in dB or dBm (depending on `CONF:SPEC:MOD:LIM`).

<Abs/Rel> Indicates whether relative (dB) or absolute (dBm) limit and level values are returned (depending on `CONF:SPEC:MOD:LIM`).

<Status> Result of the limit check in character data form

PASSED
no limit exceeded

FAILED
limit exceeded

Example:

```
READ:SPEC:MOD?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
...
```

Manual operation: See "Modulation Spectrum Table" on page 22

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

FETCh:SPECtrum:MODulation:REFerence?
READ:SPECtrum:MODulation:REFerence[:IMMediate]?

This command starts the measurement and returns the (internal) reference power of the "Modulation Spectrum". This command is only available for "Modulation Spectrum Table" evaluations (see "Modulation Spectrum Table" on page 22).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Level1> measured reference power in dBm

<Level2> measured reference power in dBm

<RBW> resolution bandwidth used to measure the reference power in Hz; (30 kHz)

Example: `READ:SPECtrum:MODulation:REFerence:IMMediate?`

Usage: Query only

Manual operation: See "Modulation Spectrum Table" on page 22

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

READ:SPECtrum:MODulation:GATing?
READ:WSPectrum:MODulation:GATing?

This command reads out the gating settings for gated "Modulation Spectrum" measurements (see "Modulation Spectrum Table" on page 22).

The returned values can be used to set the gating interval for "list" measurements (i.e. a series of measurements in zero span mode at several offset frequencies). This is done in the "Spectrum" mode using the `SENSe:LIST` subsystem (see `[SENSe:]LIST:POWer:SET`).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see chapter 11.4.4, "Triggering Measurements", on page 173).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that 50-90% of the active part of the "Slot to measure" (excluding TSC) is measured.

Example: `READ:WSP:MOD:GAT?`
Results:
`0.00032303078,0.00016890001`

Usage: Query only

11.6.6 Power vs Slot Results

The following commands are required to query the results of the "Power vs Slot" evaluation. For details on the individual results see "Power vs Slot" on page 24.

READ vs FETCh commands

Note that for each result type, two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` commands.

FETCh:BURSt:SPOWer:SLOT<s>:ALL:AVERage?....240
READ:BURSt:SPOWer:SLOT<Slot>:ALL:AVERage?....240
FETCh:BURSt:SPOWer:SLOT<s>:ALL:CRESt?....241
READ:BURSt:SPOWer:SLOT<Slot>:ALL:CRESt?....241
FETCh:BURSt:SPOWer:SLOT<s>:ALL:MAXimum?....242
READ:BURSt:SPOWer:SLOT<Slot>:ALL:MAXimum?....242
FETCh:BURSt:SPOWer:SLOT<s>:CURRent:AVERage?....243
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:AVERage?....243
FETCh:BURSt:SPOWer:SLOT<s>:CURRent:CRESt?....244
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:CRESt?....244
FETCh:BURSt:SPOWer:SLOT<s>:CURRent:MAXimum?....245
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:MAXimum?....245
FETCh:BURSt:SPOWer:SLOT<s>:DELTatosync?....246
READ:BURSt:SPOWer:SLOT<Slot>:DELTatosync?....246
FETCh:BURSt:SPOWer:SLOT<s>:LIMit:FAIL?....247
READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?....247

FETCh:BURSt:SPOWer:SLOT<s>:ALL:AVERage?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:AVERage?

This command starts the measurement and reads out the average power for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value
Average
Default unit: dBm

Example:

\\ Preset the instrument
```
*RST
```
\\ Enter the GSM option K10
```
INSTrument:SELect GSM
```
\\ Switch to single sweep mode and stop sweep
```
INITiate:CONTinuous OFF;:ABORt
```
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
```
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
```
\\ First Slot to measure = 0
```
CONFigure:MS:CHANnel:MSLots:OFFSet 0
```
\\ Activate PvT (Power vs Time) measurement
```
LAY:ADD? '1',LEFT,PTF
```
\\ **Note:** 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
```
READ:BURSt:SPOWer:SLOT1:ALL:AVERage?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:ALL:CRESt?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:CRESt?

This command starts the measurement and reads out the crest factor for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value
Crest factor
Default unit: dB

Example:

```
\\ Preset the instrument
*RST
\\ Enter the GSM option K10
INSTrument:SELect GSM
\\ Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
\\ First Slot to measure = 0
CONFigure:MS:CHANnel:MSLots:OFFSet 0
\\ Activate PvT (Power vs Time) measurement
LAY:ADD? '1',LEFT,PTF
\\ Note: 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
READ:BURSt:SPOWer:SLOT1:ALL:CRESt?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:ALL:MAXimum?
READ:BURSt:SPOWer:SLOT<Slot>:ALL:MAXimum?

This command starts the measurement and reads out the maximum power for the selected slot for all measured frames.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Maximum

Default unit: dBm

Example:

```
\\ Preset the instrument
*RST
\\ Enter the GSM option K10
INSTrument:SELect GSM
\\ Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
\\ First Slot to measure = 0
CONFigure:MS:CHANnel:MSLots:OFFSet 0
\\ Activate PvT (Power vs Time) measurement
LAY:ADD? '1',LEFT,PTF
\\ Note: 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
READ:BURSt:SPOWer:SLOT1:ALL:MAXimum?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:AVERage?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:AVERage?

This command starts the measurement to read out the average power for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Average

Default unit: dBm

Example:

```
\\ Preset the instrument
*RST
\\ Enter the GSM option K10
INSTrument:SELect GSM
\\ Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
\\ First Slot to measure = 0
CONFigure:MS:CHANnel:MSLots:OFFSet 0
\\ Activate PvT (Power vs Time) measurement
LAY:ADD? '1',LEFT,PTF
\\ Note: 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
READ:BURSt:SPOWer:SLOT1:CURRent:AVERage?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:CRESt?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:CRESt?

This command starts the measurement to read out the crest factor for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Crest factor

Default unit: dB

Example:

```
\\ Preset the instrument
*RST
\\ Enter the GSM option K10
INSTrument:SELect GSM
\\ Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
\\ First Slot to measure = 0
CONFigure:MS:CHANnel:MSLots:OFFSet 0
\\ Activate PvT (Power vs Time) measurement
LAY:ADD? '1',LEFT,PTF
\\ Note: 'READ' starts a new single sweep annd then reads the
results. Use 'FETCh' to query several results!
READ:BURSt:SPOWer:SLOT1:CURRent:CRESt?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:CURRent:MAXimum?
READ:BURSt:SPOWer:SLOT<Slot>:CURRent:MAXimum?

This command starts the measurement to read out the maximum power for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot s must be within the slot scope, i.e. (First slot to measure) ≦ s ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

Maximum

Default unit: dBm

Example:

```
\\ Preset the instrument
*RST
\\ Enter the GSM option K10
INSTrument:SELect GSM
\\ Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
\\ First Slot to measure = 0
CONFigure:MS:CHANnel:MSLots:OFFSet 0
\\ Activate PvT (Power vs Time) measurement
LAY:ADD? '1',LEFT,PTF
\\ Note: 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
READ:BURSt:SPOWer:SLOT1:CURRent:MAXimum?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:DELTatosync?
READ:BURSt:SPOWer:SLOT<Slot>:DELTatosync?

This command starts the measurement of the "Delta to Sync" value for the selected slot in the current frame.

This command is only available when the "Power vs Time" measurement is selected (see "PvT Full Burst" on page 25).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Suffix:

<Slot> <0..7>
Slot number to measure power on. The selected slot must be within the slot scope, i.e.
(First slot to measure) ≦ <slot> ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:

<Result> numeric value

For equal timeslot length: the expected offset
For non-equal time slots: the measured offset
(See `CONFigure[:MS]:CHANnel:FRAMe:EQUal` on page 146)

Default unit: dBm

Example:
\\ Preset the instrument
```
RST
```
\\ Enter the GSM option K10
```
INSTrument:SELect GSM
```
\\ Switch to single sweep mode and stop sweep
```
INITiate:CONTinuous OFF;:ABORt
```
\\ Set the slot scope: Use all 8 slots for the PvT measurement.
\\ Number of slots to measure = 8
```
CONFigure:MS:CHANnel:MSLots:NOFSlots 8
```
\\ First Slot to measure = 0
```
CONFigure:MS:CHANnel:MSLots:OFFSet 0
```
\\ Activate PvT (Power vs Time) measurement
```
LAY:ADD? '1',LEFT,PTF
```
\\ **Note:** 'READ' starts a new single sweep annd then reads the results. Use 'FETCh' to query several results!
```
READ:BURSt:SPOWer:SLOT1:DELTatosync?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

FETCh:BURSt:SPOWer:SLOT<s>:LIMit:FAIL?
READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?

This command starts a "Power vs Time" measurement and queries the result of the limit check for the selected slot.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

Note: in manual operation, the result of the limit check for an individual slot is included in the "Power vs Slot" results (see "Power vs Slot" on page 24).

Suffix:
<Slot> <0..7>
Slot number to perform the limit check on. The selected slot must be within the slot scope, i.e.
(First slot to measure) ≦ <slot> ≦ (First slot to measure + Number of Slots to measure - 1).

Return values:
<Result> 1 | 0 | ON | OFF

1 | ON
Pass

0 | OFF
Fail

Example:
```
READ:BURSt:SPOWer:SLOT1:LIMit:FAIL?
```

Usage: Query only

Manual operation: See "Power vs Slot" on page 24

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

11.6.7 Transient Spectrum Results

The following commands are required to query the results of the "Modulation Spectrum Table" evaluation. For details on the individual results see "Modulation Spectrum Table" on page 22.

READ vs FETCh commands

Note that two commands are provided which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

FETCh:SPECtrum:SWITching[:ALL]?....248
READ:SPECtrum:SWITching[:ALL]?....248
FETCh:SPECtrum:SWITching:REFerence?....249
READ:SPECtrum:SWITching:REFerence[:IMMediate]....249
READ:SPECtrum:SWITching:REFerence:GATing?....249

FETCh:SPECtrum:SWITching[:ALL]?
READ:SPECtrum:SWITching[:ALL]?

This command starts the measurement and reads out the transient spectrum.

This command is only available for "Transient Spectrum Table" evaluations (see "Transient Spectrum Table" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Placeholder>	curently irrelevant
<Freq1>	Absolute offset frequency in Hz
<Freq2>	Absolute offset frequency in Hz
<Level>	Measured level at the offset frequency in dB or dBm. For more information see `CONFigure:SPECtrum:SWITching:LIMIT`).
<Limit>	Limit at the offset frequency in dB or dBm For more information see `CONFigure:SPECtrum:SWITching:LIMIT`).

<Abs/Rel> Indicates whether relative (dB) or absolute (dBm) limit and level values are returned.
For more information see `CONFigure:SPECtrum:SWITching:LIMIT`).

<Status> Result of the limit check in character data form

PASSED
no limit exceeded

FAILED
limit exceeded

Example:
```
READ:SPEC:SWIT?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
```

Usage: Query only

Manual operation: See "Transient Spectrum Table" on page 28

FETCh:SPECtrum:SWITching:REFerence?
READ:SPECtrum:SWITching:REFerence[:IMMediate]

This command starts the measurement and returns the measured reference power of the "Transient Spectrum".

This command is only available for "Transient Spectrum Table" evaluations (see "Transient Spectrum Table" on page 28).

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

The result is a list of partial result strings separated by commas.

Return values:

<Level1> measured reference power in dBm

<Level2> measured reference power in dBm

<RBW> resolution bandwidth used to measure the reference power in Hz

Example:
```
READ:SPECtrum:SWITching:REFerence:IMMediate?
```

Manual operation: See "Transient Spectrum Table" on page 28

READ:SPECtrum:SWITching:REFerence:GATing?

This command reads out the gating settings for gated measurements of the reference power of the "Transient Spectrum" measurement (see "Transient Spectrum Table" on page 28).

Prior to this command make sure you set the correct Trigger Mode ("IF power" or "External") and Trigger Offset (see chapter 11.4.4, "Triggering Measurements", on page 173).

Return values:

<TriggerOffset> Calculated trigger offset, based on the user-defined "Trigger Offset" and "Frame Configuration", such that the useful part of the "Slot to measure" is measured.

<GateLength> Calculated gate length, based on the user-defined "Trigger Offset" and "Frame Configuration", such that the useful part of the "Slot to measure" is measured.

Example: `READ:SPEC:SWIT:REF:GAT?`
Result:
`0.00000185076,0.00054277002`

Usage: Query only

11.6.8 Trigger to Sync Results

The following commands are required to query the (numeric) results of a Trigger to Sync measurement. For details on the individual results see "Trigger to Sync Table" on page 30.

READ vs FETCh commands

Note that two commands are provided for each result type which are almost identical.

The `READ` command starts the measurement and reads out the result. When the measurement is started the R&S FSW GSM application is automatically set to single sweep.

Further results of the measurement can then be queried without performing a new measurement via the `FETCh:BURSt` command.

FETCh:BURSt:PTEMplate:TRGS:AVERage?....250
FETCh:BURSt:PTEMplate:TRGS:CURRent?....250
FETCh:BURSt:PTEMplate:TRGS:MAXimum?....250
FETCh:BURSt:PTEMplate:TRGS:MINimum?....250
FETCh:BURSt:PTEMplate:TRGS:SDEViation?....250
READ:BURSt:PTEMplate:TRGS:AVERage?....250
READ:BURSt:PTEMplate:TRGS:CURRent?....250
READ:BURSt:PTEMplate:TRGS:MAXimum?....250
READ:BURSt:PTEMplate:TRGS:MINimum?....251
READ:BURSt:PTEMplate:TRGS:SDEViation?....251

FETCh:BURSt:PTEMplate:TRGS:AVERage?
FETCh:BURSt:PTEMplate:TRGS:CURRent?
FETCh:BURSt:PTEMplate:TRGS:MAXimum?
FETCh:BURSt:PTEMplate:TRGS:MINimum?
FETCh:BURSt:PTEMplate:TRGS:SDEViation?
READ:BURSt:PTEMplate:TRGS:AVERage?
READ:BURSt:PTEMplate:TRGS:CURRent?
READ:BURSt:PTEMplate:TRGS:MAXimum?

READ:BURSt:PTEMplate:TRGS:MINimum?
READ:BURSt:PTEMplate:TRGS:SDEViation?

This command starts a "Trigger to Sync" measurement and reads out the time between the *external* trigger event and the middle of the TSC of the Slot to Measure.

This command is only available if an external trigger is selected and the "Trigger to Sync" measurement is active (see `TRIGger[:SEQuence]:SOURce` on page 177 and "Trigger to Sync Graph" on page 29).

Return values:

<Result> numeric value
Trigger to Sync time
Default unit: S

Example:

```
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt
// Set external trigger mode
TRIGger1:SEQuence:SOURce EXTernal
// Set minimum capture time to speed up measurement
SENSe1:SWEep:TIME MINimum
// Auto set trigger offset
// Note: Correct frame / slot configuration assumed!
CONFigure:MS:AUTO:TRIGger ONCE
// Activate Trigger to Sync measurement
LAY:ADD? '1',LEFT,TGSG
LAY:ADD? '1',BEL,TGST
//Query standard deviation of trigger to sync time.
// Note: 'READ' starts a new single sweep and then reads the results.
// Use 'FETCh' to query several results!
READ:BURS:PTEM:TRGS:SDEV?
```

Usage: Query only

11.6.9 Limit Check Results

The following command is required to query the results of a limit check for a specific result display.

Useful commands for retrieving limit check results described elsewhere:

- `READ:BURSt:SPOWer:SLOT<Slot>:LIMit:FAIL?` on page 247

Remote commands exclusive to retrieving limit check results:

CALCulate<n>:LIMit<k>:FAIL?.....252

CALCulate<n>:LIMit<k>:FAIL?

This command queries the result of the limit check of the limit line indicated in the selected measurement window. Note that a complete sweep must have been performed to obtain a valid result. A synchronization with *OPC, *OPC? Or *WAI should therefore be provided.

Suffix:

<k> 1 | 2
The number of the limit line to access (Power vs Time Graph only)
1: Max trace (-> upper limit line)
2: Min trace (-> lower limit line)

Return values:

<Result> 1 | 0

1
Failed (see table 11-6)

0
Passed (see table 11-6)

Example: `CALCulate2:LIMit1:FAIL?`

Usage: Query only

Manual operation: See "Modulation Spectrum Graph" on page 20
See "PvT Full Burst" on page 25
See "Transient Spectrum Graph" on page 27

For a detailed example see chapter 11.10.1, "Programming Example: Determining the EVM", on page 269.

Table 11-6: Meaning of return values depending on result display

Result display	SCPI	Return values
Power vs Time Graph	CALCulate<n>:LIMit**1**:FAIL?	1: the limit check of the upper limit line against the max hold trace failed 0: passed
	CALCulate<n>:LIMit**2**:FAIL?	1: the limit check of the lower limit line against the min hold trace failed 0: passed
Mod. Spectrum Graph	CALCulate<n>:LIMit:FAIL?	1: the limit check of the upper limit line against the average trace failed 0: passed
Tra. Spectrum Graph	CALCulate<n>:LIMit:FAIL?	1: the limit check of the upper limit line against the max hold trace failed 0: passed

11.6.10 Retrieving Marker Results

Useful commands for retrieving marker results described elsewhere:

- `CALCulate<n>:DELTamarker<m>:Y?` on page 253

Remote commands exclusive to retrieving marker results:

CALCulate<n>:DELTamarker<m>:X....253
CALCulate<n>:DELTamarker<m>:X:RELative?....253
CALCulate<n>:DELTamarker<m>:Y?....253
CALCulate<n>:MARKer<m>:X....254
CALCulate<n>:MARKer<m>:Y?....254

CALCulate<n>:DELTamarker<m>:X <Position>

This command moves a delta marker to a particular coordinate on the x-axis.

If necessary, the command activates the delta marker and positions a reference marker to the peak power.

Example: `CALC:DELT:X?`
Outputs the (absolute) x-value of delta marker 1.

Manual operation: See "X-value" on page 112

CALCulate<n>:DELTamarker<m>:X:RELative?

This command queries the relative position of a delta marker on the x-axis.

If necessary, the command activates the delta marker first.

Return values:
<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: `CALC:DELT3:X:REL?`
Outputs the frequency of delta marker 3 relative to marker 1 or relative to the reference position.

Usage: Query only

CALCulate<n>:DELTamarker<m>:Y?

This command queries the relative position of a delta marker on the y-axis.

If necessary, the command activates the delta marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also `INITiate:CONTinuous` on page 183.

The unit depends on the application of the command.

Return values:
<Position> Position of the delta marker in relation to the reference marker or the fixed reference.

Example: INIT:CONT OFF
Switches to single sweep mode.
INIT;*WAI
Starts a sweep and waits for its end.
CALC:DELT2 ON
Switches on delta marker 2.
CALC:DELT2:Y?
Outputs measurement value of delta marker 2.

Usage: Query only

CALCulate<n>:MARKer<m>:X <Position>

This command moves a marker to a particular coordinate on the x-axis.

If necessary, the command activates the marker.

If the marker has been used as a delta marker, the command turns it into a normal marker.

Parameters:
<Position> Numeric value that defines the marker position on the x-axis.
Range: The range depends on the current x-axis range.

Example: CALC:MARK2:X 1.7MHz
Positions marker 2 to frequency 1.7 MHz.

Manual operation: See "Marker Table" on page 18
See "X-value" on page 112

CALCulate<n>:MARKer<m>:Y?

This command queries the position of a marker on the y-axis.

If necessary, the command activates the marker first.

To get a valid result, you have to perform a complete measurement with synchronization to the end of the measurement before reading out the result. This is only possible for single sweeps. See also INITiate:CONTinuous on page 183.

Return values:
<Result> Result at the marker position.

Example: INIT:CONT OFF
Switches to single measurement mode.
CALC:MARK2 ON
Switches marker 2.
INIT;*WAI
Starts a measurement and waits for the end.
CALC:MARK2:Y?
Outputs the measured value of marker 2.

Usage: Query only

Manual operation: See "Marker Table" on page 18

11.7 Importing and Exporting I/Q Data and Results

The I/Q data to be evaluated in the GSM application can not only be measured by the GSM application itself, it can also be imported to the application, provided it has the correct format. Furthermore, the evaluated I/Q data from the GSM application can be exported for further analysis in external applications.

For details on importing and exporting I/Q data see chapter 8, "I/Q Data Import and Export", on page 118.

MMEMory:LOAD:IQ:STATe....255
MMEMory:STORe:IQ:COMMent....255
MMEMory:STORe:IQ:STATe....255

MMEMory:LOAD:IQ:STATe 1,<FileName>

This command restores I/Q data from a file.

The file extension is *.iqw.

Parameters:

<FileName> String containing the path and name of the source file.

Example:
```
MMEM:LOAD:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iqw'
```
Loads IQ data from the specified file.

Usage: Setting only

Manual operation: See "Import" on page 119
See "IQ Import" on page 119

MMEMory:STORe:IQ:COMMent <Comment>

This command adds a comment to a file that contains I/Q data.

Parameters:

<Comment> String containing the comment.

Example:
```
MMEM:STOR:IQ:COMM 'Device test 1b'
```
Creates a description for the export file.
```
MMEM:STOR:IQ:STAT 1, 'C:
\R_S\Instr\user\data.iq.tar'
```
Stores I/Q data and the comment to the specified file.

MMEMory:STORe:IQ:STATe 1, <FileName>

This command writes the captured I/Q data to a file.

The file extension is *.iq.tar. By default, the contents of the file are in 32-bit floating point format.

Parameters:

1

<FileName> String containing the path and name of the target file.

Example: `MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'`
Stores the captured I/Q data to the specified file.

11.8 Status Reporting System

The status reporting system stores all information on the current operating state of the instrument, e.g. information on errors or limit violations which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via IEC bus.

The GSM application uses the standard status registers of the R&S FSW. However, some registers are used differently. Only those differences are described in the following sections.

For details on the common R&S FSW status registers refer to the description of remote control basics in the R&S FSW User Manual.

*RST does not influence the status registers.

Description of the Status Registers

All the status registers are the same as those provided by the base system, with the exception of the following registers, which are provided by the R&S FSW and are not available from the R&S FSW GSM application command tree:

- `STATus:QUESTionable:ACPLimit`
- `STATus:QUESTionable:LIMit2`
- `STATus:QUESTionable:LMARgin<1|2>`

The commands to query the contents of the following status registers are described in chapter 11.8.3, "Querying the Status Registers", on page 260.

- The STATus:QUEStionable:SYNC Register....256
- STATus:QUEStionable:DIQ Register....257
- Querying the Status Registers....260

11.8.1 The STATus:QUEStionable:SYNC Register

The `STATus:QUEStionable:SYNC` register contains application-specific information about synchronization errors or errors during symbol detection. If any errors occur in this register, the status bit #11 in the `STATus:QUEStionable` register is set to 1.

Each active channel uses a separate `STATus:QUEStionable:SYNC` register. Thus, if the status bit #11 in the `STATus:QUEStionable` register indicates an error, the error may have occurred in any of the channel-specific `STATus:QUEStionable:SYNC` registers. In this case, you must check the register of each channel to determine which channel caused the error. By default, querying the status of a register always returns the result for the currently selected channel. However, you can specify any other channel name as a query parameter.

Table 11-7: Meaning of the bits used in the STATus:QUEStionable:SYNC register

Bit No.	Meaning
0	BURSt not found This bit is set if no burst is found in the measurements/premeasurements for phase/frequency error or carrier power vs time.
1	SYNC not found This bit is set if the synchronization sequence (or training sequence) of the TSC is not found in the measurements/premeasurements for phase/frequency error or carrier power vs time.
2 to 14	These bits are not used
15	This bit is always 0

11.8.2 STATus:QUEStionable:DIQ Register

This register contains information about the state of the digital I/Q input and output. This register is available with option Digital Baseband Interface (R&S FSW-B17)Digital Baseband Interface (R&S FSW-B17).

The status of the `STATus:QUESTionable:DIQ` register is indicated in bit 14 of the `STATus:QUESTionable` register.

You can read out the state of the register with `STATus:QUEStionable:DIQ:CONDition?` on page 258 and `STATus:QUEStionable:DIQ[:EVENt]?` on page 259.

Bit No.	Meaning
0	**Digital I/Q Input Device connected** This bit is set if a device is recognized and connected to the Digital Baseband Interface of the analyzer.
1	**Digital I/Q Input Connection Protocol in progress** This bit is set while the connection between analyzer and digital baseband data signal source (e.g. R&S SMU, R&S Ex-I/Q-Box) is established.
2	**Digital I/Q Input Connection Protocol error** This bit is set if an error occurred during establishing of the connect between analyzer and digital I/Q data signal source (e.g. R&S SMU, R&S Ex-I/Q-Box) is established.
3-5	not used

Bit No.	Meaning
6	**Digital I/Q Input FIFO Overload** This bit is set if the input transfer rate is too high.
7	not used
8	**Digital I/Q Output Device connected** This bit is set if a device is recognized and connected to the Digital I/Q Output.
9	**Digital I/Q Output Connection Protocol in progress** This bit is set while the connection between analyzer and digital I/Q data signal source (e.g. R&S SMU, R&S Ex-I/Q-Box) is established.
10	**Digital I/Q Output Connection Protocol error** This bit is set if an error occurred while the connection between analyzer and digital I/Q data signal source (e.g. R&S SMU, R&S Ex-I/Q-Box) is established.
11-14	not used
15	This bit is always set to 0.

STATus:QUEStionable:DIQ:CONDition?....258
STATus:QUEStionable:DIQ:ENABle....258
STATus:QUEStionable:DIQ:NTRansition....259
STATus:QUEStionable:DIQ:PTRansition....259
STATus:QUEStionable:DIQ[:EVENt]?....259

STATus:QUEStionable:DIQ:CONDition? <ChannelName>

This command reads out the CONDition section of the `STATus:QUEStionable:DIQ:CONDition` status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Example: `STAT:QUES:DIQ:COND?`

Usage: Query only

STATus:QUEStionable:DIQ:ENABle <BitDefinition>, <ChannelName>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:
<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:
<SumBit> Range: 0 to 65535

Usage: SCPI confirmed

STATus:QUEStionable:DIQ:NTRansition <BitDefinition>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:
<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:
<BitDefinition> Range: 0 to 65535

STATus:QUEStionable:DIQ:PTRansition <BitDefinition>,<ChannelName>

This command controls the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:
<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Setting parameters:
<BitDefinition> Range: 0 to 65535

STATus:QUEStionable:DIQ[:EVENt]? <ChannelName>

This command queries the contents of the "EVENt" section of the `STATus:QUEStionable:DIQ` register for IQ measurements.

Readout deletes the contents of the "EVENt" section.

Query parameters:
<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Example:
```
STAT:QUES:DIQ?
```

Usage: Query only

11.8.3 Querying the Status Registers

The following commands are required to query the status of the R&S FSW and the GSM application.

For more information on the contents of the status registers see:

- chapter 11.8.1, "The STATus:QUEStionable:SYNC Register", on page 256
- chapter 11.8.2, "STATus:QUEStionable:DIQ Register", on page 257

- General Status Register Commands....260
- Reading Out the EVENt Part....260
- Reading Out the CONDition Part....261
- Controlling the ENABle Part....261
- Controlling the Negative Transition Part....262
- Controlling the Positive Transition Part....262

11.8.3.1 General Status Register Commands

STATus:PRESet....260
STATus:QUEue[:NEXT]?....260

STATus:PRESet

This command resets the edge detectors and `ENABle` parts of all registers to a defined value. All `PTRansition` parts are set to `FFFFh`, i.e. all transitions from 0 to 1 are detected. All `NTRansition` parts are set to 0, i.e. a transition from 1 to 0 in a `CONDition` bit is not detected. The `ENABle` part of the `STATus:OPERation` and `STATus:QUEStionable` registers are set to 0, i.e. all events in these registers are not passed on.

Usage: Event

STATus:QUEue[:NEXT]?

This command queries the most recent error queue entry and deletes it.

Positive error numbers indicate device-specific errors, negative error numbers are error messages defined by SCPI. If the error queue is empty, the error number 0, "No error", is returned.

Usage: Query only

11.8.3.2 Reading Out the EVENt Part

STATus:OPERation[:EVENt]?
STATus:QUEStionable[:EVENt]?

STATus:QUEStionable:ACPLimit[:EVENt]? <ChannelName>
STATus:QUEStionable:DIQ[:EVENt]? <ChannelName>
STATus:QUEStionable:LIMit<n>[:EVENt]? <ChannelName>
STATus:QUEStionable:SYNC[:EVENt]? <ChannelName>

This command reads out the EVENt section of the status register.

The command also deletes the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

11.8.3.3 Reading Out the CONDition Part

STATus:OPERation:CONDition?
STATus:QUEStionable:CONDition?
STATus:QUEStionable:ACPLimit:CONDition? <ChannelName>
STATus:QUEStionable:DIQ:CONDition? <ChannelName>
STATus:QUEStionable:LIMit<n>:CONDition? <ChannelName>
STATus:QUEStionable:SYNC:CONDition? <ChannelName>

This command reads out the CONDition section of the status register.

The command does not delete the contents of the EVENt section.

Query parameters:

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

Usage: Query only

11.8.3.4 Controlling the ENABle Part

STATus:OPERation:ENABle <SumBit>
STATus:QUEStionable:ENABle <SumBit>
STATus:QUEStionable:ACPLimit:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:ENABle <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:ENABle <BitDefinition>, <ChannelName>

This command controls the ENABle part of a register.

The ENABle part allows true conditions in the EVENt part of the status register to be reported in the summary bit. If a bit is 1 in the enable register and its associated event bit transitions to true, a positive transition will occur in the summary bit reported to the next higher level.

Parameters:

<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

11.8.3.5 Controlling the Negative Transition Part

STATus:OPERation:NTRansition <SumBit>
STATus:QUEStionable:NTRansition <SumBit>
STATus:QUEStionable:ACPLimit:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:NTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:NTRansition <BitDefinition>,<ChannelName>

This command controls the Negative TRansition part of a register.

Setting a bit causes a 1 to 0 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:
<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

11.8.3.6 Controlling the Positive Transition Part

STATus:OPERation:PTRansition <SumBit>
STATus:QUEStionable:PTRansition <SumBit>
STATus:QUEStionable:ACPLimit:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:LIMit<n>:PTRansition <SumBit>,<ChannelName>
STATus:QUEStionable:SYNC:PTRansition <BitDefinition>,<ChannelName>

These commands control the Positive TRansition part of a register.

Setting a bit causes a 0 to 1 transition in the corresponding bit of the associated register. The transition also writes a 1 into the associated bit of the corresponding EVENt register.

Parameters:
<BitDefinition> Range: 0 to 65535

<ChannelName> String containing the name of the channel.
The parameter is optional. If you omit it, the command works for the currently active channel.

11.9 Deprecated Commands (Commands for Compatibility)

Note that the following commands are maintained for compatibility reasons only. Use the specified alternative commands for new remote control programs.

CONFigure:BURSt:ETIMe[:IMMediate]....263
CONFigure:BURSt:MACCuracy[:IMMediate]....263
CONFigure:BURSt:MERRor[:IMMediate]....263
CONFigure:BURSt:PFERror[:IMMediate]....263
CONFigure:BURSt:POWer[:IMMediate]....263
CONFigure:BURSt:PTEMplate[:IMMediate]....263
CONFigure:BURSt:PTEMplate:SELect....263
CONFigure:SPECtrum:MODulation[:IMMediate]....263
CONFigure:SPECtrum:SELect....263
CONFigure:SPECtrum:SWITching[:IMMediate]....264
CONFigure:TRGS[:IMMediate]....264
CONFigure:WSPectrum:MODulation[:IMMediate]....264
CONFigure[:MS]:MULTi:BURSt:CONStell....264
CONFigure[:MS]:MULTi:BURSt:DEModulation....264
CONFigure[:MS]:MULTi:BURSt:PTEMplate....264
CONFigure[:MS]:MULTi:SPECtrum:MODulation....264
CONFigure[:MS]:MULTi:SPECtrum:SWITching....264
CONFigure[:MS]:MULTi:STATe....264
CONFigure[:MS]:MULTi:....264
CONFigure[:MS]:BSEarch....264
CONFigure[:MS]:BSTHreshold....264
CONFigure[:MS]:MTYPe....265
CONFigure[:MS]:POWer:AUTO ONCE....266
CONFigure[:MS]:SSEarch....266
CONFigure:WSPectrum:MODulation:LIMIT....266
FETCh:BURSt[:MACCuracy]:FERRor:AVERage?....267
FETCh:BURSt[:MACCuracy]:FERRor:CURRent?....267
FETCh:BURSt[:MACCuracy]:FERRor:MAXimum?....267
FETCh:BURSt[:MACCuracy]:FERRor:SDEViation?....267
READ:BURSt[:MACCuracy]:FERRor:AVERage?....267
READ:BURSt[:MACCuracy]:FERRor:CURRent?....267
READ:BURSt[:MACCuracy]:FERRor:MAXimum?....267
READ:BURSt[:MACCuracy]:FERRor:SDEViation?....267
FETCh:WSPectrum:MODulation[:ALL]?....267
READ:WSPectrum:MODulation[:ALL]?....267
FETCh:WSPectrum:MODulation:REFerence?....268
READ:WSPectrum:MODulation:REFerence[:IMMediate]....268
READ:AUTO:LEVTime....268
READ:SPECtrum:WMODulation:GATing (obsolete)....269

CONFigure:BURSt:ETIMe[:IMMediate]
CONFigure:BURSt:MACCuracy[:IMMediate]
CONFigure:BURSt:MERRor[:IMMediate]
CONFigure:BURSt:PFERror[:IMMediate]
CONFigure:BURSt:POWer[:IMMediate]
CONFigure:BURSt:PTEMplate[:IMMediate]
CONFigure:BURSt:PTEMplate:SELect <Value>
CONFigure:SPECtrum:MODulation[:IMMediate]
CONFigure:SPECtrum:SELect <Mode>

CONFigure:SPECtrum:SWITching[:IMMediate]
CONFigure:TRGS[:IMMediate]
CONFigure:WSPectrum:MODulation[:IMMediate]

These commands select a specific result display. They are maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see chapter 11.5.1.2, "Working with Windows in the Display", on page 201).

Usage: Setting only

CONFigure[:MS]:MULTi:BURSt:CONStell <State>
CONFigure[:MS]:MULTi:BURSt:DEModulation <State>
CONFigure[:MS]:MULTi:BURSt:PTEMplate <State>
CONFigure[:MS]:MULTi:SPECtrum:MODulation <State>
CONFigure[:MS]:MULTi:SPECtrum:SWITching <State>
CONFigure[:MS]:MULTi:STATe <State>
CONFigure[:MS]:MULTi:

These commands are maintained for compatibility reasons only. Use the `LAYout` commands for new remote control programs (see chapter 11.5.1.2, "Working with Windows in the Display", on page 201).

CONFigure[:MS]:BSEarch <State>

This command toggles between active burst search and inactive burst search.

Note

This command is retained for compatibility with R&S FS-K5 only. Use `CONFigure:MS:SYNC:MODE BURSt` or `CONFigure:MS:SYNC:MODE ALL` instead (see `CONFigure[:MS]:SYNC:MODE` on page 189).

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

ON
Burst search on

OFF
Burst search off

*RST: 1

CONFigure[:MS]:BSTHreshold <Value>

This command changes the burst find threshold.

Note

This command is retained for compatibility with R&S FS-K5 only. Due to the improved measurement capabilities of this GSM analysis software, this remote control command (and the function behind) is not required any more.

Parameters for setting and query:

<Value> numeric value

Threshold for burst detection

Default unit: dB

Example:
```
CONF:BSTH 10 DB
```

Mode: GSM

CONFigure[:MS]:MTYPe <Value>

This command sets the modulation type of all slots.

Note: This command is retained for compatibility with R&S FS-K5 only.

Parameters for setting and query:

<Value> GMSK | EDGE

Modulation type

*RST: GMSK

Example:
```
// Enter the GSM option K10
INSTrument:SELect GSM
// Old FS-K5 commands
CONFigure:MS:MTYPe EDGE
// Please use the following K10 commands instead
// K5: 'GMSK' -> K10: 'GMSK'
// K5: 'EDGE' -> K10: 'PSK8'
CONFigure:MS:CHANnel:SLOT0:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT1:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT2:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT3:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT4:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT5:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT6:MTYPe PSK8
CONFigure:MS:CHANnel:SLOT7:MTYPe PSK8
// Old FS-K5 commands
CONFigure:MS:CHANnel:SLOT1:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT1:MTYPe?
// -> GMSK
// Please use the following K10 commands instead
CONFigure:MS:CHANnel:MSLots:MEASure?
// -> 0 This is the slot number of the 'slot to measure'
// Set and query the modulation of the 'slot to measure'
CONFigure:MS:CHANnel:SLOT0:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT0:MTYPe?
// -> GMSK
```

Mode: GSM

CONFigure[:MS]:POWer:AUTO ONCE

This command is used to perform an auto level measurement immediately.

Note that this command is maintained for compatibility reasons only. Use `CONFigure[:MS]:AUTO:LEVel ONCE` on page 199 for new remote control programs.

CONFigure[:MS]:SSEarch <State>

This command is retained for compatibility with R&S FSW-K5 only. In new K10 remote scripts use `CONFigure:MS:SYNC:MODE TSC` or `CONFigure:MS:SYNC:MODE ALL` instead (see `CONFigure[:MS]:SYNC:MODE` on page 189).

Parameters for setting and query:

<State> 1 | 0 | ON | OFF

ON
TSC search on

OFF
TSC search off

*RST: 1

Example:
```
CONF:SSE ON
```

CONFigure:WSPectrum:MODulation:LIMIT <Mode>

This command selects whether the list results (power and limit values) of the "(Wide) Modulation Spectrum" measurement are returned in a relative (dB) or absolute (dBm) unit. This command is only available when the "Wide Modulation Spectrum" measurement is selected (see `CONFigure:WSPectrum:MODulation[:IMMediate]` on page 264).

Note that this command is maintained for compatibility reasons only. Use the `CONFigure:SPECtrum:MODulation:LIMIT` command for new remote control programs.

Parameters for setting and query:

<Mode> ABSolute | RELative

*RST: RELative

Example:
```
// Select Wide Modulation Spectrum measurement
// (gated zero span measurement)
CONFigure:WSPectrum:MODulation:IMMediate
// Absolute power and limit results in dBm
CONFigure:WSPectrum:MODulation:LIMit ABSolute
// Run one measurement and query absolute list results
READ:WSPectrum:MODulation:ALL?
// -> 0,929200000,929200000,-104.41,-65.00,ABS,PASSED, ...
```

FETCh:BURSt[:MACCuracy]:FERRor:AVERage?
FETCh:BURSt[:MACCuracy]:FERRor:CURRent?
FETCh:BURSt[:MACCuracy]:FERRor:MAXimum?
FETCh:BURSt[:MACCuracy]:FERRor:SDEViation?
READ:BURSt[:MACCuracy]:FERRor:AVERage?
READ:BURSt[:MACCuracy]:FERRor:CURRent?
READ:BURSt[:MACCuracy]:FERRor:MAXimum?
READ:BURSt[:MACCuracy]:FERRor:SDEViation?

This command starts the measurement and reads out the result of the Frequency Error.

This command is retained for compatibility with R&S FS-K5 only. Use the `READ:BURSt[:MACCuracy]:FREQuency` or `FETCh:BURSt[:MACCuracy]:FREQuency` commands in newer remote control programs.

Return values:

<Result> numeric value
Frequency error
Default unit: Hz

Example: `READ:BURS:FERR:SDEV?`

Usage: Query only

FETCh:WSPectrum:MODulation[:ALL]?
READ:WSPectrum:MODulation[:ALL]?

This command starts the measurement and reads out the result of the measurement of the "Modulation Spectrum" of the mobile or base station.

These commands are retained for compatibility with previous R&S signal and spectrum analyzers only. For newer remote control programs, use the `READ:SPECtrum:MODulation[:ALL]` or `FETCh:SPECtrum:MODulation[:ALL]?` commands instead.

The result is a list of partial result strings separated by commas.

Return values:

<Placeholder> curently irrelevant

<Freq1> Absolute offset frequency in Hz

<Freq2> Absolute offset frequency in Hz

<Level> Measured level at the offset frequency in dB or dBm.

<Limit> Limit at the offset frequency in dB or dBm.

<Abs/Rel> Indicates whether relative (dB) or absolute (dBm) limit and level values are returned.

<Status> Result of the limit check in character data form

PASSED
no limit exceeded

FAILED
limit exceeded

Example:
```
READ:WSP:MOD?
0,998200000,998200000,-84.61,-56.85,REL,PASSED,
0,998400000,998400000,-85.20,-56.85,REL,PASSED,
...
```

Usage: Query only

FETCh:WSPectrum:MODulation:REFerence?
READ:WSPectrum:MODulation:REFerence[:IMMediate]

This command starts the measurement and returns the measured reference power of the "Modulation Spectrum".

These commands are retained for compatibility with previous R&S signal and spectrum analyzers only. For newer remote control programs, use the `READ:SPECtrum:MODulation:REFerence[:IMMediate]?` or `FETCh:SPECtrum:MODulation:REFerence?` commands instead.

The result is a list of partial result strings separated by commas.

Return values:

<Level1> measured reference power in dBm

<Level2> measured reference power in dBm

<RBW> resolution bandwidth used to measure the reference power in Hz

Example:
```
READ:WSPectrum:MODulation:REFerence:IMMediate?
```

READ:AUTO:LEVTime

This command is used to perform a single measurement to detect the required reference level and the trigger offset automatically.

Note that this command is maintained for compatibility reasons only. Use `CONFigure[:MS]:AUTO:LEVel ONCE` and `CONFigure[:MS]:AUTO:TRIGger ONCE` for new remote control programs.

Return values:

<ReferenceLevel> The detected reference level

*RST: 0 dBm
Default unit: variable

<TriggerLevel> The detected trigger level

Range: -50 dBm to 20 dBm
*RST: -20 dBm

<TriggerOffset> The detected time offset between the trigger event and the start of the sweep

*RST: 0 s

Example:
```
READ:AUTO:LEVT?
// --> PASSED,9.2404,-0.00000007695,1.4,0
```

READ:SPECtrum:WMODulation:GATing (obsolete)

This command reads out the gating settings for gated `Wide Modulation Spectrum` measurements. It is identical to `READ:SPECtrum:WMODulation:GATing (obsolete)` and is maintained for compatibility reasons only.

Example:
```
READ:SPEC:WMOD:GAT?
```

Mode: GSM

11.10 Programming Examples

The following examples demonstrate how to configure and perform GSM measurements in a remote environment.

- Programming Example: Determining the EVM.....269
- Programming Example: Measuring an AQPSK Signal.....273
- Programming Example: Measuring the Power for Access Bursts.....276

11.10.1 Programming Example: Determining the EVM

This example demonstrates how to configure an EVM measurement in a remote environment.

```
//---------- Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ

// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM
```

```
//---------- Trigger settings --------------------
// Use these settings only if an external trigger is connected
// to the TRIGGER INPUT connector on the front panel of the R&S FSW.
// Otherwise ignore these commands.
// Define the use of an external trigger.
TRIG:SOUR EXT
// Determine the offset from the trigger event to the frame start
// (start of active part of slot 0).
// Define a trigger offset of 2 µs.
TRIG:HOLD 2us


//---------- Configuring Data Acquisition ---------------------
// Define a capture time of 1 second (>200 GSM frames)
SENSe:SWEep:TIME 1 s
// Define a statistic count of 200, i.e. 200 GSM frames are evaluated statistically.
SENSe:SWEep:COUNt 200


//---------- Configuring the result display ------------
// Delete result display 3 and 4 and
// activate the following result displays:
// 1: Magnitude Capture (default, upper left)
// 2: PvT Full burst (default, below Mag Capt)
// 3: Modulation Accuracy (next to Mag Capt)
// 4: Modulation Spectrum Table (next to PvT)
// 5: EVM vs Time measurement (full width, bottom)
LAY:REM '3'
LAY:REM '4'
LAY:ADD:WIND? '1',RIGH,MACC
LAY:ADD:WIND? '2',RIGH,MST
LAY:ADD:WIND? '2',BEL,ETIMe

//---------- Signal Description ------------
// Configure a base station DUT with normal power class 1
CONF:DEV:TYPE BTSNormal
CONF:NETW PGSM
CONF:MS:NETW:FREQ:BAND 900
CONF:POW:CLAS 1

//---------- Frame/slot configuration ------------
CONF:CHAN:FRAM:EQU OFF
// Set slot 1: On, Higher Symbol Rate burst, 16QAM, Wide Pulse, TSC 0
CONFigure:MS:CHANnel:SLOT1:STATe ON
CONFigure:MS:CHANnel:SLOT1:TYPE HB
CONFigure:MS:CHANnel:SLOT1:MTYPe QAM16
CONFigure:MS:CHANnel:SLOT1:FILTer WIDE
CONFigure:MS:CHANnel:SLOT1:TSC 0

// Set slot 2: On, Normal burst, GMSK modulation, TSC 3 (Set 1)
```

```
CONFigure:MS:CHANnel:SLOT2:STATe ON
CONFigure:MS:CHANnel:SLOT2:TYPE NB
CONFigure:MS:CHANnel:SLOT2:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT2:TSC 3,1
// Query TSC number
CONFigure:MS:CHANnel:SLOT2:TSC? TSC
// -> 3
// Query Set number
CONFigure:MS:CHANnel:SLOT2:TSC? SET
// -> 1

// Set slot 3: On, Normal burst, GMSK modulation, User-defined TSC
CONFigure:MS:CHANnel:SLOT3:STATe ON
CONFigure:MS:CHANnel:SLOT3:TYPE NB
CONFigure:MS:CHANnel:SLOT3:MTYPe GMSK
CONFigure:MS:CHANnel:SLOT3:TSC USER
CONFigure:MS:CHANnel:SLOT3:TSC?
// -> USER
// Set User TSC bits
CONFigure:MS:CHANnel:SLOT3:TSC:USER '10111101100110010000100001'
// Query User TSC bits
CONFigure:MS:CHANnel:SLOT3:TSC:USER?
// -> 10111101100110010000100001

// Set slot 4: Off
CONFigure:MS:CHANnel:SLOT4:STATe OFF

// Set slot 5: Off
CONFigure:MS:CHANnel:SLOT5:STATe OFF

// Set slot 6: Off
CONFigure:MS:CHANnel:SLOT6:STATe OFF

// Set slot 7: Off
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 1 (slot to measure) for single-slot measurements,
// (e.g. EVM, modulation spectrum).
CONF:CHAN:MSL:MEAS 1
// Configure slots 0-3 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure = 4
CONF:CHAN:MSL:NOFS 4
CONF:CHAN:MSL:OFFS 0
// Use 'sequence estimator' for the symbol decision
CONFigure:MS:DEMod:DECision SEQuence
// Replace detected Tail & TSC bits by the standard bits
```

```
CONFigure:MS:DEMod:STDBits STD

//---------- PvT Measurement settings -----------------
// Use Gaussian PvT filter with 500 kHz for single-carrier BTS
CONF:BURS:PTEM:FILT G500
// Align the limit line to mid of TSC for each slot.
CONF:BURS:PTEM:TAL PSL

//---------- Spectrum Measurement settings -----------------
// Absolute power and limit (remote) results in dBm
CONFigure:SPECtrum:MODulation:LIMit ABSolute
// Use compact version of narrow frequency list to save time
CONFigure:WSPectrum:MODulation:LIST:SELect NSParse


//---------- Performing the Measurements-----
INITiate:IMMediate;*WAI

//---------- Retrieving Results-------------

// Read trace data in binary format
FORMat:DATA REAL,32

// Query current magnitude capture trace data
TRAC1:DATA? TRACe1
//-> trace data

// Query the current power vs time trace
TRAC2:DATA? TRACe4
//-> trace data

// Query the result of the power vs time limit check for max trace
CALCulate2:LIMit1:FAIL?
// -> 1

// Query max EVM trace data
TRAC5:DATA? TRACe2
//-> trace data

// Query the maximum EVM value for slot 1 (slot to measure) in current measurement
FETCh:BURSt:MACCuracy:EVM:PEAK:CURR?
// -> 0.62063819169998169

// Query the maximum EVM value for slot 1 (slot to measure) in all 200
// measured GSM frames
FETCh:BURSt:MACCuracy:EVM:PEAK:MAX?
// -> 0.76938760280609131

// Query the averaged EVM RMS value for slot 1 (slot to measure) in all 200
// measured GSM frames
```

```
FETCh:BURSt:MACCuracy:EVM:RMS:AVERage?
// -> 0.19639170169830322

// Query the absolute mod spectrum table results
FETCH:SPECtrum:MODulation:ALL?
// -> 00,933200000,933200000,-86.36,-70.23,ABS,PASSED, ...
// Query the reference power of the mod spectrum
FETCh:SPECtrum:MODulation:REFerence?
// -> -11.13,-11.13,30000

//---------- Exporting Captured I/Q Data-------------

// Query the sample rate for the captured I/Q data
// Note: The returned value depends on
// - Capture time: SENSe:SWEep:TIME?
// - Mod frequency list: CONFigure:WSPectrum:MODulation:LIST:SELect?
// Therefore only query the sample rate afterwards.
TRAC:IQ:SRAT?
// -> 6500000

// The number of samples can be calculated as follows
// floor((CaptureTime + 577 us) * SampleRate) =
// = floor((1s + 577 us) * 6.5 MHz)
// = floor(6503750.5)
// = 6503750 samples
// Query the captured I/Q data
TRACe1:IQ:DATA:MEMory? 0,6503750

// Alternatively store the captured I/Q data to a file.
MMEM:STOR:IQ:STAT 1, 'C:\R_S\Instr\user\data.iq.tar'
```

11.10.2 Programming Example: Measuring an AQPSK Signal

This example demonstrates how to configure a GSM measurement of an AQPSK modulated signal in a remote environment.

```
//------------ Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ
```

```
// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM


//----------- Slot 0 configuration ------------
// Setup slot 0 for VAMOS AQPSK modulation
// Activate slot
CONFigure:MS:CHANnel:SLOT0:STATe ON
// Normal burst
CONFigure:MS:CHANnel:SLOT0:TYPE NB
// AQPSK (VAMOS) modulation
CONFigure:MS:CHANnel:SLOT0:MTYPe AQPSk
// Subchannel Power Imbalance Ratio (SCPIR) = 4 dB
CONFigure:MS:CHANnel:SLOT0:SCPir 4
// Subchannel 1: User TSC
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC USER
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC?
// -> USER
// Subchannel 1: Set User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC:USER '10111101100110010000100001'
// Subchannel 1: Query User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel1:TSC:USER?
// -> 10111101100110010000100001
// Subchannel 2: User TSC
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC USER
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC?
// -> USER
// Subchannel 2: Set User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC:USER '110101111111010011001110100'
// Subchannel 2: Query User TSC bits
CONFigure:MS:CHANnel:SLOT0:SUBChannel2:TSC:USER?
// -> 110101111111010011001110100

//----------- Slot 1 configuration ------------
// Activate slot 1
CONFigure:MS:CHANnel:SLOT1:STATe ON
// Normal Burst
CONFigure:MS:CHANnel:SLOT1:TYPE NB
// AQPSK (VAMOS) modulation
CONFigure:MS:CHANnel:SLOT1:MTYPe AQPSk
// Subchannel 1: TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC 0,1
// Subchannel 1: Query TSC number and Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC?
// -> 0,1
// Subchannel 1: Query TSC number
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC? TSC
// -> 0
// Subchannel 1: Query Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel1:TSC? SET
```

```
// -> 1
// Subchannel 2: TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC 0,2
// Subchannel 2: Query TSC number and Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC?
// -> 0,2
// Subchannel 2: Query TSC number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC? TSC
// -> 0
// Subchannel 2: Query Set number
CONFigure:MS:CHANnel:SLOT1:SUBChannel2:TSC? SET
// -> 2

//----------- Slot 2-7 configuration ------------
CONFigure:MS:CHANnel:SLOT2:STATe OFF
CONFigure:MS:CHANnel:SLOT3:STATe OFF
CONFigure:MS:CHANnel:SLOT4:STATe OFF
CONFigure:MS:CHANnel:SLOT5:STATe OFF
CONFigure:MS:CHANnel:SLOT6:STATe OFF
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 0 (slot to measure) for single-slot measurements,
// (e.g. EVM, modulation spectrum).
CONFigure:MS:CHANnel:MSL:MEASure 0
// Configure slots 0-1 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure =2
CONFigure:MS:CHANnel:MSL:NOFS 2
CONFigure:MS:CHANnel:MSL:OFFSet 0
// Use 'sequence estimator' for the symbol decision
CONFigure:MS:DEMod:DECision SEQuence


//---------- Configuring Data Acquisition ----------------------
// Define a statistic count of 10, i.e. 10 GSM frames are evaluated statistically.
SENSe:SWEep:COUNt 10

// Define a capture time for 10 (statistic count) + 2 (headroom) GSM frames
// Capture Time = (10+2) frames * 4.615 ms/frame = 0.0554 s
// Thus all 10 (statistic count) frames can be analyzed with a single capture.
SENSe:SWEep:TIME 0.0554 s


//--------------Performing the Measurement-----
// Initiates a new measurement and waits until the sweep has finished.
INITiate:IMMediate;*WAI
```

```
//---------------Retrieving Results-------------
// Query the maximum EVM value for slot 0 (slot to measure) in current GSM frame
FETCh:BURSt:MACCuracy:EVM:PEAK:CURR?
// -> 0.62063819169998169
// Query the maximum EVM value for slot 0 (slot to measure) in all 10
//(statistic count) GSM frames
FETCh:BURSt:MACCuracy:EVM:PEAK:MAX?
// -> 0.76938760280609131
// Query the averaged EVM RMS value for slot 1 (slot to measure) in all 10
// (statistic count) GSM frames
FETCh:BURSt:MACCuracy:EVM:RMS:AVERage?
// -> 0.19639170169830322
```

11.10.3 Programming Example: Measuring the Power for Access Bursts

This example demonstrates how to configure a GSM power measurement of a GMSK modulated signal with access bursts in a remote environment.

```
//------------ Preparing the application ------------
// Preset the instrument
*RST
// Enter the GSM option K10
INSTrument:SELect GSM
// Switch to single sweep mode and stop sweep
INITiate:CONTinuous OFF;:ABORt


//---------- Frequency and Level ---------------------
// Set center frequency to 935 MHz
SENSe:FREQuency:CENTer 935 MHZ

// Set Ref. Level to 10 dBm
DISPlay:WINDow:TRACe:Y:SCALe:RLEVel:RF 10 DBM


//----------- Slot 0 configuration ------------
// Activate slot 0
CONFigure:MS:CHANnel:SLOT0:STATe ON
// Normal Burst
CONFigure:MS:CHANnel:SLOT0:TYPE NB
// GMSK modulation
CONFigure:MS:CHANnel:SLOT0:MTYPe GMSK
// TSC 0 (Set 1)
CONFigure:MS:CHANnel:SLOT0:TSC 0,1


//----------- Slot 1 configuration ------------
// Activate slot 1
```

```
CONFigure:MS:CHANnel:SLOT1:STATe ON
// Access Burst
CONFigure:MS:CHANnel:SLOT1:TYPE AB
// Set TS0
CONFigure:MS:CHANnel:SLOT1:TSC TS0
// Query TS
CONFigure:MS:CHANnel:SLOT1:TSC?
// -> TS0
// Access burst has a timing advance (offset) from slot start of 1 symbol
CONFigure:MS:CHANnel:SLOT1:TADV 1


//----------- Slot 2-7 configuration ------------
CONFigure:MS:CHANnel:SLOT2:STATe OFF
CONFigure:MS:CHANnel:SLOT3:STATe OFF
CONFigure:MS:CHANnel:SLOT4:STATe OFF
CONFigure:MS:CHANnel:SLOT5:STATe OFF
CONFigure:MS:CHANnel:SLOT6:STATe OFF
CONFigure:MS:CHANnel:SLOT7:STATe OFF


//---------- Demodulation and Slot Scope------------
// Configure slot 1 (slot to measure) for single-slot measurements,
// (e.g. phase error, modulation spectrum).
CONF:CHAN:MSL:MEAS 1
// Configure slot 0-1 for multi-slot measurements
// (e.g. PvT, transient spectrum).
// Set First slot to measure = 0
// Set No. of slots to measure = 2
CONF:CHAN:MSL:NOFS 2
CONF:CHAN:MSL:OFFS 0


//---------- PvT Measurement settings -----------------
// Check PvT filter
CONF:BURS:PTEM:FILT?
// -> G1000

// Align the limit line to mid of TSC/TS for each slot.
CONF:BURS:PTEM:TAL PSL


//--------------Performing the Measurement-----
// Initiates a new measurement and waits until the sweep has finished.
INITiate:IMMediate;*WAI


//---------------Retrieving Results-------------

// In PvT limits are checked against the max in min traces.
```

```
// Query the max power vs time trace
TRAC2:DATA? TRACe2
// Query the result of the power vs time limit check for max trace
CALCulate2:LIMit1:FAIL?
// -> 0
// Query the min power vs time trace
TRAC2:DATA? TRACe3
// Query the result of the power vs time limit check for min trace
CALCulate2:LIMit2:FAIL?
// -> 0
// Query the result of the power vs time limit check for slot 0
FETCh:BURSt:SPOWer:SLOT0:LIM:FAIL?
// -> 0
// Query the result of the power vs time limit check for slot 1
FETCh:BURSt:SPOWer:SLOT1:LIM:FAIL?
// -> 0

// Query the maximum phase error value for slot 1 (slot to measure) in
// current GSM frame
FETCh:BURSt:MACCuracy:PERRor:PEAK:CURR?
// -> -0.21559642255306244
// Query the maximum phase error value for slot 1 (slot to measure) in
// all 200 GSM frames
FETCh:BURSt:MACCuracy:PERRor:PEAK:MAX?
// -> 0.35961171984672546
// Query the averaged phase error RMS value for slot 1 (slot to measure) in
// all 200 GSM frames
FETCh:BURSt:MACCuracy:PERRor:RMS:AVERage?
// -> 0.082186274230480194
```

A Annex: Reference

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A.1 List of abbreviations

16QAM	16-ary Quadrature Amplitude Modulation
32QAM	32-ary Quadrature Amplitude Modulation
3GPP	3rd Generation Partnership Project
8PSK	Phase Shift Keying with 8 phase states
AQPSK	Adaptive Quadrature Amplitude Modulation
ARFCN	Absolute Radio Frequency Channel Number
BTS	Base Transceiver Station
DL	Downlink (MS to BTS)
DUT	Device Under Test
EDGE	Enhanced Data Rates for GSM Evolution
EGPRS	Enhanced General Packet Radio, synonym for EDGE.
EGPRS2	Enhanced General Packet Radio and support of additional modulation/coding schemes and higher symbol rate.
FDMA	Frequency Division Multiplex Access
GMSK	Gaussian Minimum Shift Keying
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSCSD	High-Speed Circuit-Switch Data
IF	Intermediate Frequency
MS	Mobile Station
NSP	Normal Symbol Period
PCL	Power Control Level
PDF	Probability Density Function
PvT	Power vs Time
QPSK	Quadrature Phase Shift Keying

SCPIR	Subchannel Power Imbalance Ratio
SFH	Slow Frequency Hopping
TDMA	Time Division Multiplex Access
TSC	Training Sequence Code
UL	Uplink (BTS to MS)
VAMOS	Voice services over Adaptive Multi-user Channels on One Slot
YIG	Yttrium Iron Garnet

A.2 I/Q Data File Format (iq-tar)

I/Q data is packed in a file with the extension `.iq.tar`. An iq-tar file contains I/Q data in binary format together with meta information that describes the nature and the source of data, e.g. the sample rate. The objective of the iq-tar file format is to separate I/Q data from the meta information while still having both inside one file. In addition, the file format allows you to preview the I/Q data in a web browser, and allows you to include user-specific data.

The iq-tar container packs several files into a single `.tar` archive file. Files in `.tar` format can be unpacked using standard archive tools (see http://en.wikipedia.org/wiki/Comparison_of_file_archivers) available for most operating systems. The advantage of `.tar` files is that the archived files inside the `.tar` file are not changed (not compressed) and thus it is possible to read the I/Q data directly within the archive without the need to unpack (untar) the `.tar` file first.

Sample iq-tar files

If you have the optional R&S FSW VSA application (R&S FSW-K70), some sample iq-tar files are provided in the `C:/R_S/Instr/user/vsa/DemoSignals` directory on the R&S FSW.

Contained files

An iq-tar file must contain the following files:

- **I/Q parameter XML file**, e.g. `xyz.xml`
  Contains meta information about the I/Q data (e.g. sample rate). The filename can be defined freely, but there must be only one single I/Q parameter XML file inside an iq-tar file.
- **I/Q data binary file**, e.g. `xyz.complex.float32`
  Contains the binary I/Q data of all channels. There must be only one single I/Q data binary file inside an iq-tar file.

Optionally, an iq-tar file can contain the following file:

- **I/Q preview XSLT file**, e.g. `open_IqTar_xml_file_in_web_browser.xslt`
  Contains a stylesheet to display the I/Q parameter XML file and a preview of the I/Q data in a web browser.

A sample stylesheet is available at http://www.rohde-schwarz.com/file/open_IqTar_xml_file_in_web_browser.xslt.

A.2.1 I/Q Parameter XML File Specification

The content of the I/Q parameter XML file must comply with the XML schema `RsIqTar.xsd` available at: http://www.rohde-schwarz.com/file/RsIqTar.xsd.

In particular, the order of the XML elements must be respected, i.e. iq-tar uses an "ordered XML schema". For your own implementation of the iq-tar file format make sure to validate your XML file against the given schema.

The following example shows an I/Q parameter XML file. The XML elements and attributes are explained in the following sections.

Sample I/Q parameter XML file: xyz.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-stylesheet type="text/xsl"
href="open_IqTar_xml_file_in_web_browser.xslt"?>
<RS_IQ_TAR_FileFormat fileFormatVersion="1"
xsi:noNamespaceSchemaLocation="RsIqTar.xsd"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <Name>FSV-K10</Name>
  <Comment>Here is a comment</Comment>
  <DateTime>2011-01-24T14:02:49</DateTime>
  <Samples>68751</Samples>
  <Clock unit="Hz">6.5e+006</Clock>
  <Format>complex</Format>
  <DataType>float32</DataType>
  <ScalingFactor unit="V">1</ScalingFactor>
  <NumberOfChannels>1</NumberOfChannels>
<DataFilename>xyz.complex.float32</DataFilename>
<UserData>
  <UserDefinedElement>Example</UserDefinedElement>
</UserData>
  <PreviewData>...</PreviewData>
</RS_IQ_TAR_FileFormat>
```

Element	Description
RS_IQ_TAR_File-Format	The root element of the XML file. It must contain the attribute `fileFormatVersion` that contains the number of the file format definition. Currently, `fileFormatVersion` "2" is used.
Name	Optional: describes the device or application that created the file.
Comment	Optional: contains text that further describes the contents of the file.
DateTime	Contains the date and time of the creation of the file. Its type is `xs:dateTime` (see `RsIqTar.xsd`).

Element	Description
Samples	Contains the number of samples of the I/Q data. For multi-channel signals all channels have the same number of samples. One sample can be: • A complex number represented as a pair of I and Q values • A complex number represented as a pair of magnitude and phase values • A real number represented as a single real value See also `Format` element.
Clock	Contains the clock frequency in Hz, i.e. the sample rate of the I/Q data. A signal generator typically outputs the I/Q data at a rate that equals the clock frequency. If the I/Q data was captured with a signal analyzer, the signal analyzer used the clock frequency as the sample rate. The attribute `unit` must be set to "Hz".
Format	Specifies how the binary data is saved in the I/Q data binary file (see `DataFilename` element). Every sample must be in the same format. The format can be one of the following: • `complex`: Complex number in cartesian format, i.e. I and Q values interleaved. I and Q are unitless • `real`: Real number (unitless) • `polar`: Complex number in polar format, i.e. magnitude (unitless) and phase (rad) values interleaved. Requires `DataType` = `float32` or `float64`
DataType	Specifies the binary format used for samples in the I/Q data binary file (see `DataFilename` element and chapter A.2.2, "I/Q Data Binary File", on page 284). The following data types are allowed: • `int8`: 8 bit signed integer data • `int16`: 16 bit signed integer data • `int32`: 32 bit signed integer data • `float32`: 32 bit floating point data (IEEE 754) • `float64`: 64 bit floating point data (IEEE 754)
ScalingFactor	Optional: describes how the binary data can be transformed into values in the unit Volt. The binary I/Q data itself has no unit. To get an I/Q sample in the unit Volt the saved samples have to be multiplied by the value of the `ScalingFactor`. For polar data only the magnitude value has to be multiplied. For multi-channel signals the `ScalingFactor` must be applied to all channels. The attribute `unit` must be set to "`V`". The `ScalingFactor` must be > 0. If the `ScalingFactor` element is not defined, a value of 1 V is assumed.
NumberOfChannels	Optional: specifies the number of channels, e.g. of a MIMO signal, contained in the I/Q data binary file. For multi-channels, the I/Q samples of the channels are expected to be interleaved within the I/Q data file (see chapter A.2.2, "I/Q Data Binary File", on page 284). If the `NumberOfChannels` element is not defined, one channel is assumed.
DataFilename	Contains the filename of the I/Q data binary file that is part of the iq-tar file. It is recommended that the filename uses the following convention: <xyz>.<Format>.<Channels>ch.<Type> • <xyz> = a valid Windows file name • <Format> = complex, polar or real (see `Format` element) • <Channels> = Number of channels (see `NumberOfChannels` element) • <Type> = float32, float64, int8, int16, int32 or int64 (see `DataType` element) Examples: • xyz.complex.1ch.float32 • xyz.polar.1ch.float64 • xyz.real.1ch.int16 • xyz.complex.16ch.int8

Element	Description
UserData	Optional: contains user, application or device-specific XML data which is not part of the iq-tar specification. This element can be used to store additional information, e.g. the hardware configuration. User data must be valid XML content.
PreviewData	Optional: contains further XML elements that provide a preview of the I/Q data. The preview data is determined by the routine that saves an iq-tar file (e.g. R&S FSW). For the definition of this element refer to the `RsIqTar.xsd` schema. Note that the preview can be only displayed by current web browsers that have JavaScript enabled and if the XSLT stylesheet `open_IqTar_xml_file_in_web_browser.xslt` is available.

Example: ScalingFactor

Data stored as `int16` and a desired full scale voltage of 1 V

`ScalingFactor` = 1 V / maximum int16 value = 1 V / 2^{15} = 3.0517578125e-5 V

Scaling Factor	Numerical value	Numerical value x ScalingFactor
Minimum (negative) int16 value	- 2^{15} = - 32768	-1 V
Maximum (positive) int16 value	2^{15}-1= 32767	0.999969482421875 V

Example: PreviewData in XML

```
<PreviewData>
    <ArrayOfChannel length="1">
      <Channel>
        <PowerVsTime>
          <Min>
            <ArrayOfFloat length="256">
              <float>-134</float>
              <float>-142</float>
              ...
              <float>-140</float>
            </ArrayOfFloat>
          </Min>
          <Max>
            <ArrayOfFloat length="256">
              <float>-70</float>
              <float>-71</float>
              ...
              <float>-69</float>
            </ArrayOfFloat>
          </Max>
        </PowerVsTime>
        <Spectrum>
          <Min>
            <ArrayOfFloat length="256">
              <float>-133</float>
              <float>-111</float>
              ...
              <float>-111</float>
```

```
        </ArrayOfFloat>
      </Min>
      <Max>
        <ArrayOfFloat length="256">
          <float>-67</float>
          <float>-69</float>
          ...
          <float>-70</float>
          <float>-69</float>
        </ArrayOfFloat>
      </Max>
    </Spectrum>
    <IQ>
      <Histogram width="64" height="64">0123456789...0</Histogram>
    </IQ>
  </Channel>
 </ArrayOfChannel>
</PreviewData>
```

A.2.2 I/Q Data Binary File

The I/Q data is saved in binary format according to the format and data type specified in the XML file (see `Format` element and `DataType` element). To allow reading and writing of streamed I/Q data, all data is interleaved, i.e. complex values are interleaved pairs of I and Q values and multi-channel signals contain interleaved (complex) samples for channel 0, channel 1, channel 2 etc. If the `NumberOfChannels` element is not defined, one channel is presumed.

Example: Element order for real data (1 channel)

```
I[0],                       // Real sample 0
I[1],                       // Real sample 1
I[2],                       // Real sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

```
I[0], Q[0],                 // Real and imaginary part of complex sample 0
I[1], Q[1],                 // Real and imaginary part of complex sample 1
I[2], Q[2],                 // Real and imaginary part of complex sample 2
...
```

Example: Element order for complex polar data (1 channel)

```
Mag[0], Phi[0],             // Magnitude and phase part of complex sample 0
Mag[1], Phi[1],             // Magnitude and phase part of complex sample 1
Mag[2], Phi[2],             // Magnitude and phase part of complex sample 2
...
```

Example: Element order for complex cartesian data (3 channels)

Complex data: I[channel no][time index], Q[channel no][time index]

```
I[0][0], Q[0][0],           // Channel 0, Complex sample 0
I[1][0], Q[1][0],           // Channel 1, Complex sample 0
I[2][0], Q[2][0],           // Channel 2, Complex sample 0

I[0][1], Q[0][1],           // Channel 0, Complex sample 1
I[1][1], Q[1][1],           // Channel 1, Complex sample 1
I[2][1], Q[2][1],           // Channel 2, Complex sample 1

I[0][2], Q[0][2],           // Channel 0, Complex sample 2
I[1][2], Q[1][2],           // Channel 1, Complex sample 2
I[2][2], Q[2][2],           // Channel 2, Complex sample 2
...
```

Example: Element order for complex cartesian data (1 channel)

This is an example of how to store complex cartesian data in float32 format using MATLAB®.

```
% Save vector of complex cartesian I/Q data, i.e. iqiqiq...
N = 100
iq = randn(1,N)+1j*randn(1,N)
fid = fopen('xyz.complex.float32','w');
for k=1:length(iq)
  fwrite(fid,single(real(iq(k))),'float32');
  fwrite(fid,single(imag(iq(k))),'float32');
end
fclose(fid)
```

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